EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)

REA.A – Marie Skłodowska-Curie Actions & Support to Experts
A.3 – MSCA Staff Exchanges

GRANT AGREEMENT

Project 101182521 — MIRACLES

PREAMBLE

This **Agreement** ('the Agreement') is **between** the following parties:

on the one part,

the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and

on the other part,

1. 'the coordinator':

KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU), PIC 999844961, established in K DONELAICIO 73, KAUNAS LT-44029, Lithuania,

and the following other beneficiaries, if they sign their 'accession form' (see Annex 3 and Article 40):

2. **LATVIJAS UNIVERSITATE (LU)**, PIC 999871830, established in RAINA BOULEVARD 19, RIGA 1586, Latvia,

3. **USTAV POLYMEROV SLOVENSKEJ AKADEMIEVIED VEREJNA VYSKUMNA INSTITUCIA (PISAS)**, PIC 998528574, established in DUBRAVSKA CESTA 5798/9, BRATISLAVA 845 41, Slovakia,

4. **VYSOKA SKOLA CHEMICKO-TECHNOLOGICKA V PRAZE (VSCHT)**, PIC 999867853, established in TECHNICKA 5, PRAHA 166 28, Czechia,

5. **CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)**, PIC 999979500, established in PIAZZALE ALDO MORO 7, ROMA 00185, Italy,

6. **LULEA TEKNISKA UNIVERSITET (LTU)**, PIC 999876874, established in UNIVERSITETSOMRADET PORSON, LULEA 971 87, Sweden,

7. **SYNPO AKCIOVA SPOLECNOST (SYNPO)**, PIC 988900063, established in S K NEUMANNA 1316 ZELENE PREDMESTI, PARDUBICE 532 07, Czechia,

8. **UAB STIDO (STIDO)**, PIC 879736069, established in VERSLININKU G. 23, TAURU K., TAURAGES R. LT-72116, Lithuania,

9. **COMEC - COSTRUZIONI MECCANICHE INNOVATIVE SRL (COMEC)**, PIC 950066695, established in VIALE ABRUZZO 330, CHIETI CH 66013, Italy,

10. **UAB SPORTINE AVIACIJA IR KO (SA)**, PIC 918723182, established in DEBESU STR. 16 POCIUNU K., PRIENU R., PRIENAI 59327, Lithuania,

Unless otherwise specified, references to 'beneficiary' or 'beneficiaries' include the coordinator and affiliated entities (if any).

If only one beneficiary signs the grant agreement ('mono-beneficiary grant'), all provisions referring to the 'coordinator' or the 'beneficiaries' will be considered — mutatis mutandis — as referring to the beneficiary.

The parties referred to above have agreed to enter into the Agreement.

By signing the Agreement and the accession forms, the beneficiaries accept the grant and agree to implement the action under their own responsibility and in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

The Agreement is composed of:

Preamble

Terms and Conditions (including Data Sheet)

Annex 1 Description of the action[1]

Annex 2 Estimated budget for the action

Annex 2a Additional information on unit costs and contributions (if applicable)

Annex 3 Accession forms (if applicable)[2]

Annex 3a Declaration on joint and several liability of affiliated entities (if applicable)[3]

Annex 4 Model for the financial statements

Annex 5 Specific rules (if applicable)

[1] Template published on Portal Reference Documents.
[2] Template published on Portal Reference Documents.
[3] Template published on Portal Reference Documents.

TERMS AND CONDITIONS

TABLE OF CONTENTS

DATA SHEET

1. General data

Project summary:

Project summary
Fibre-reinforced plastic composites (FRPC) are widely used in advanced fields such as aviation, shipbuilding, wind energy, etc. FRPC structures, during exploitation, lose loadbearing capacity because of local damage, icing, water absorption and other factors. The specific objective of the MIRACLES fundamental research is FRPC with the tailored additional functionality of damage monitoring, de-icing, self-sensing, and moisture barrier protection. These functions are implemented using thin MXene-dopped coatings and (or) interlayers. Novel two-dimensional MXene nanoparticles uniquely combine high electrical conductivity and mechanical properties realised under the high alignment of the particles in thin coatings and (or) interlayers. The workflow in the project combines theoretical modelling and experimental research with nano-engineered technologies for validation, upscaling, and demonstrating. Novel eco-friendly methods of MXene delamination and exfoliation will be explored together with the possibilities of reagent recycling. An automated spray and print methods with precisely controlled nanoparticle quality will be explored. Layer sensitivity will be improved with the new technology using different nanoparticle and polymer configurations. New surface temperature annealing, antioxidants, and protective polymer coatings will be explored to increase stability further. The objectives and contributions to the impact will be achieved through 117 secondments for 205 person-months, homework, and other networking actions. The interdisciplinary and intersectoral consortium of six academic and four industrial partners from six EU countries has complementary expertise in Materials Engineering, Mechanical Engineering, and Chemical Sciences. By starting from TRL3, the project plans to grow forward to TRL6. The greatest impact of this innovation will be achieved by making FRPC structures safer, cleaner and cheaper.

Keywords:

- Coating and films
- Intelligent materials, self-assembled materials
- Materials engineering
- Mechanical and manufacturing engineering (shaping, mounting, joining, separation)
- New materials: oxides, alloys, composite, organic-inorganic hybrid, nanoparticles
- MXene, fibre-reinforced plastic composite, local curing, de-icing, self-sensing, barrier properties

Project number: 101182521

Project name: Multifunctional fibre-reinforced plastic composites with MXene layers

Project acronym: MIRACLES

Call: HORIZON-MSCA-2023-SE-01

Topic: HORIZON-MSCA-2023-SE-01-01

Type of action: HORIZON TMA MSCA Staff Exchanges

Granting authority: European Research Executive Agency

Grant managed through EU Funding & Tenders Portal: Yes (eGrants)

Project starting date: fixed date: 1 January 2025

Project end date: 31 December 2028

Project duration: 48 months

Consortium agreement: Yes

2. Participants

List of participants:

N°	Role	Short name	Legal name	Ctry	PIC	Total eligible contrib.	Max grant amount
1	COO	KTU	KAUNO TECHNOLOGIJOS UNIVERSITETAS	LT	999844961	193 200.00	193 200.00

N°	Role	Short name	Legal name	Ctry	PIC	Total eligible contrib.	Max grant amount
2	BEN	LU	LATVIJAS UNIVERSITATE	LV	999871830	184 000.00	184 000.00
3	BEN	PISAS	USTAV POLYMEROV SLOVENSKEJ AKADEMIEVIED VEREJNA VYSKUMNA INSTITUCIA	SK	998528574	115 000.00	115 000.00
4	BEN	VSCHT	VYSOKA SKOLA CHEMICKO-TECHNOLOGICKA V PRAZE	CZ	999867853	27 600.00	27 600.00
5	BEN	CNR	CONSIGLIO NAZIONALE DELLE RICERCHE	IT	999979500	115 000.00	115 000.00
6	BEN	LTU	LULEA TEKNISKA UNIVERSITET	SE	999876874	82 800.00	82 800.00
7	BEN	SYNPO	SYNPO AKCIOVA SPOLECNOST	CZ	988900063	41 400.00	41 400.00
8	BEN	STIDO	UAB STIDO	LT	879736069	92 000.00	92 000.00
9	BEN	COMEC	COMEC - COSTRUZIONI MECCANICHE INNOVATIVE SRL	IT	950066695	46 000.00	46 000.00
10	BEN	SA	UAB SPORTINE AVIACIJA IR KO	LT	918723182	46 000.00	46 000.00
Total						943 000.00	943 000.00

Coordinator:

– KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU)

3. Grant

Maximum grant amount, total estimated eligible costs and contributions and funding rate:

Total eligible contributions (unit, flat-rate and lump sum contributions and financing not linked to costs)	Maximum grant amount (Annex 2)	Maximum grant amount (award decision)
943 000.00	943 000.00	943 000.00

Grant form: Unit

Grant mode: Action grant

Budget categories/activity types:

- A. Contributions for seconded staff
  - A.1 Top-up allowance
  - A.5 Special needs allowance

- B. Institutional contributions
  - B.1 Research, training and networking contribution
  - B.2 Management and indirect contribution

Cost eligibility options:

- In-kind contributions eligible costs

Budget flexibility: Yes (flexibility with conditions)

4. Reporting, payments and recoveries

4.1 Continuous reporting (art 21)

Deliverables: see Funding & Tenders Portal Continuous Reporting tool

4.2 Periodic reporting and payments

Reporting and payment schedule (art 21, 22):

Reporting					Payments	
Reporting periods			Type	Deadline	Type	Deadline (time to pay)
RP No	Month from	Month to				
					Initial prefinancing	30 days from entry into force/10 days before starting date – whichever is the latest
1	1	24	Periodic report	60 days after end of reporting period	Interim payment	90 days from receiving periodic report
2	25	48	Periodic report	60 days after end of reporting period	Final payment	90 days from receiving periodic report

Prefinancing payments and guarantees:

Prefinancing payment	
Type	Amount
Prefinancing 1 (initial)	612 950.00

Reporting and payment modalities (art 21, 22):

Mutual Insurance Mechanism (MIM): Yes

MIM contribution: 5% of the maximum grant amount (47 150.00), retained from the initial prefinancing

Restrictions on distribution of initial prefinancing: The prefinancing may be distributed only if the minimum number of beneficiaries set out in the call condititions (if any) have acceded to the Agreement and only to beneficiaries that have acceded.

Interim payment ceiling (if any): 90% of the maximum grant amount

No-profit rule: n/a

Late payment interest: ECB + 3.5%

Bank account for payments:

LT694010051004275690 AGBLLT2X

Conversion into euros: n/a

Reporting language: Language of the Agreement

4.3 Certificates (art 24): n/a

4.4 Recoveries (art 22)

First-line liability for recoveries:

Beneficiary termination: Beneficiary concerned

Final payment: Each beneficiary for their own debt

After final payment: Beneficiary concerned

Joint and several liability for enforced recoveries (in case of non-payment):

Individual financial responsibility: Each beneficiary is liable only for its own debts (and those of its affiliated entities, if any)

Joint and several liability of affiliated entities — n/a

5. Consequences of non-compliance, applicable law & dispute settlement forum

Suspension and termination:

Additional suspension grounds (art 31)

Additional termination grounds (art 32)

Applicable law (art 43):

Standard applicable law regime: EU law + law of Belgium

Dispute settlement forum (art 43):

Standard dispute settlement forum:

EU beneficiaries: EU General Court + EU Court of Justice (on appeal)

Non-EU beneficiaries: Courts of Brussels, Belgium (unless an international agreement provides for the enforceability of EU court judgements)

6. Other

Specific rules (Annex 5): Yes

Standard time-limits after project end:

Confidentiality (for X years after final payment): 5

Record-keeping (for X years after final payment): 5 (or 3 for grants of not more than EUR 60 000)

Reviews (up to X years after final payment): 2

Audits (up to X years after final payment): 2

Extension of findings from other grants to this grant (no later than X years after final payment): 2

Impact evaluation (up to X years after final payment): 5 (or 3 for grants of not more than EUR 60 000)

CHAPTER 1 GENERAL

ARTICLE 1 — SUBJECT OF THE AGREEMENT

This Agreement sets out the rights and obligations and terms and conditions applicable to the grant awarded for the implementation of the action set out in Chapter 2.

ARTICLE 2 — DEFINITIONS

For the purpose of this Agreement, the following definitions apply:

Actions — The project which is being funded in the context of this Agreement.

Grant — The grant awarded in the context of this Agreement.

EU grants — Grants awarded by EU institutions, bodies, offices or agencies (including EU executive agencies, EU regulatory agencies, EDA, joint undertakings, etc.).

Participants — Entities participating in the action as beneficiaries, affiliated entities, associated partners, third parties giving in-kind contributions, subcontractors or recipients of financial support to third parties.

Beneficiaries (BEN) — The signatories of this Agreement (either directly or through an accession form).

Affiliated entities (AE) — Entities affiliated to a beneficiary within the meaning of Article 187 of EU Financial Regulation 2018/1046[4] which participate in the action with similar rights and obligations as the beneficiaries (obligation to implement action tasks and right to charge costs and claim contributions).

Associated partners (AP) — Entities which participate in the action, but without the right to charge costs or claim contributions.

Purchases — Contracts for goods, works or services needed to carry out the action (e.g. equipment, consumables and supplies) but which are not part of the action tasks (see Annex 1).

Subcontracting — Contracts for goods, works or services that are part of the action tasks (see Annex 1).

In-kind contributions — In-kind contributions within the meaning of Article 2(36) of EU Financial

[4] For the definition, see Article 187 Regulation (EU, Euratom) 2018/1046 of the European Parliament and of the Council of 18 July 2018 on the financial rules applicable to the general budget of the Union, amending Regulations (EU) No 1296/2013, (EU) No 1301/2013, (EU) No 1303/2013, (EU) No 1304/2013, (EU) No 1309/2013, (EU) No 1316/2013, (EU) No 223/2014, (EU) No 283/2014, and Decision No 541/2014/EU and repealing Regulation (EU, Euratom) No 966/2012 ('EU Financial Regulation') (OJ L 193, 30.7.2018, p. 1): "**affiliated entities** [are]:
(a) entities that form a sole beneficiary [(i.e. where an entity is formed of several entities that satisfy the criteria for being awarded a grant, including where the entity is specifically established for the purpose of implementing an action to be financed by a grant)];
(b) entities that satisfy the eligibility criteria and that do not fall within one of the situations referred to in Article 136(1) and 141(1) and that have a link with the beneficiary, in particular a legal or capital link, which is neither limited to the action nor established for the sole purpose of its implementation".

Regulation 2018/1046, i.e. non-financial resources made available free of charge by third parties to a beneficiary.

Fraud — Fraud within the meaning of Article 3 of EU Directive 2017/1371[5] and Article 1 of the Convention on the protection of the European Communities' financial interests, drawn up by the Council Act of 26 July 1995[6], as well as any other wrongful or criminal deception intended to result in financial or personal gain.

Irregularities — Any type of breach (regulatory or contractual) which could impact the EU financial interests, including irregularities within the meaning of Article 1(2) of EU Regulation 2988/95[7].

Grave professional misconduct — Any type of unacceptable or improper behaviour in exercising one's profession, especially by employees, including grave professional misconduct within the meaning of Article 136(1)(c) of EU Financial Regulation 2018/1046.

Applicable EU, international and national law — Any legal acts or other (binding or non-binding) rules and guidance in the area concerned.

Portal — EU Funding & Tenders Portal; electronic portal and exchange system managed by the European Commission and used by itself and other EU institutions, bodies, offices or agencies for the management of their funding programmes (grants, procurements, prizes, etc.).

CHAPTER 2 ACTION

ARTICLE 3 — ACTION

The grant is awarded for the action **101182521** — **MIRACLES** ('action'), as described in Annex 1.

ARTICLE 4 — DURATION AND STARTING DATE

The duration and the starting date of the action are set out in the Data Sheet (see Point 1).

CHAPTER 3 GRANT

ARTICLE 5 — GRANT

5.1 Form of grant

The grant is an action grant[8] which takes the form of a unit grant.

[5] Directive (EU) 2017/1371 of the European Parliament and of the Council of 5 July 2017 on the fight against fraud to the Union's financial interests by means of criminal law (OJ L 198, 28.7.2017, p. 29).
[6] OJ C 316, 27.11.1995, p. 48.
[7] Council Regulation (EC, Euratom) No 2988/95 of 18 December 1995 on the protection of the European Communities financial interests (OJ L 312, 23.12.1995, p. 1).
[8] For the definition, see Article 180(2)(a) EU Financial Regulation 2018/1046: '**action grant**' means an EU grant to finance "an action intended to help achieve a Union policy objective".

5.2 Maximum grant amount

The maximum grant amount is set out in the Data Sheet (see Point 3) and in the estimated budget (Annex 2).

5.3 Funding rate

Not applicable

5.4 Estimated budget, budget categories and forms of funding

The estimated budget for the action is set out in Annex 2.

It contains the estimated eligible contributions for the action (unit contributions), broken down by participant and budget category.

Annex 2 also shows the types of contributions (forms of funding)[9] to be used for each budget category.

The details on the calculation of the unit contributions will be explained in Annex 2a.

5.5 Budget flexibility

The budget breakdown may be adjusted — without an amendment (see Article 39) — by transfers of units between participants, as long as this does not imply any substantive or important change to the description of the action in Annex 1. Transfers between budget categories are not allowed.

ARTICLE 6 — ELIGIBLE AND INELIGIBLE CONTRIBUTIONS

6.1 General eligibility conditions

The **general eligibility conditions** for the unit contributions are the following:

(a) the units must:

- be actually used or produced by the beneficiary in the period set out in Article 4 (with the exception of units relating to the submission of the final periodic report, which may be used or produced afterwards; see Article 21)

- be necessary for the implementation of the action and

(b) the number of units must be identifiable and verifiable, in particular supported by records and documentation (see Article 20).

6.2 Specific eligibility conditions for each budget category

For each budget category, the **specific eligibility conditions** are as follows:

A. Contributions for seconded staff

Contributions for seconded staff (A.1 Top-up allowance and A.5 Special needs allowance) are eligible,

[9] See Article 125 EU Financial Regulation 2018/1046.

if they fulfil the general eligibility conditions and are calculated as unit contributions in accordance with the method set out in Annex 2a, and if:

for A.1 Top-up allowance:

(a) the number of units declared:

(i) corresponds to the number of months spent by the seconded staff on the research and innovation activities and

(ii) does not exceed the maximum number of months (per seconded staff member) set out in the call conditions

(b) the seconded staff comply with the following conditions:

(i) be seconded full-time

(ii) be — at the date of secondment — one of the following:

- a doctoral candidate (i.e. not in possession of a doctoral degree[10])
- a post-doctoral researcher (i.e. in possession of a doctoral degree), or
- administrative, managerial or technical staff supporting research and innovation activities under the action, and

(iii) have been — at the date of secondment — actively engaged in or linked to research and innovation activities for at least 1 month at the sending:

- beneficiary (or an associated partner linked to the beneficiary and located in the same country) or
- associated partner

(c) the secondments comply with the following conditions:

(i) last at least 1 month (per seconded staff member)

(ii) be between different countries

(iii) for secondments within the EU Member States or Horizon Europe associated countries: be between different sectors (academic and non-academic)[11], except for interdisciplinary secondments, which are limited to a maximum of 1/3 of the total months spent on research and innovation activities under the action

(iv) for secondments from an EU Member State or Horizon Europe associated country: be from a beneficiary (or associated partner linked to the beneficiary) established in a EU

[10] As defined in the call conditions.

[11] For secondments from an associated partner linked to the beneficiary: only the sector (academic or non-academic) of the beneficiary counts, i.e. the associated partner linked to the beneficiary will be considered to belong to the same sector as the beneficiary.

Member State or Horizon Europe associated country to an associated partner established in a non-associated non-EU country, and

(v) for secondments to an EU Member State or Horizon Europe associated country: be from an associated partner established in an eligible non-associated non-EU country to a beneficiary (or associated partner linked to the beneficiary) established in a EU Member State or Horizon Europe associated country

(d) the contributions have been fully incurred for the benefit of the seconded staff

This condition is met if they have been fully used for the seconded staff member for whom they are claimed.

for A.5 Special needs allowance:

(a) they are used for seconded staff members with disabilities whose long-term physical, mental, intellectual or sensory impairments are certified by a competent national authority and of such nature that their participation in the action would not be possible without the special needs items or services

(b) the special needs items or services are not already covered from another source (such as social security or health insurance)

(c) the number of units declared corresponds to the number of special needs units that were needed for implementing the action.

B. Institutional contributions

Institutional contributions (B.1 Research, training and networking contribution and B.2 Management and indirect contribution) are eligible, if they are calculated as unit contributions in accordance with the method set out in Annex 2a, and if the top-up allowance is eligible.

6.3 Ineligible contributions

'Ineligible contributions' are:

(a) units that do not comply with the conditions set out above (see Article 6.1 and 6.2)

(b) units implemented during grant agreement suspension (see Article 31) and

(c) units for activities already funded under other EU grants (or grants awarded by an EU Member State, non-EU country or other body implementing the EU budget), except for the following case:

(i) Synergy actions: not applicable

(d) other:

(i) country restrictions for eligible costs: not applicable.

6.4 Consequences of non-compliance

If a beneficiary declares unit contributions that are ineligible, they will be rejected (see Article 27).

This may also lead to other measures described in Chapter 5.

CHAPTER 4 GRANT IMPLEMENTATION

SECTION 1 CONSORTIUM: BENEFICIARIES, AFFILIATED ENTITIES AND OTHER PARTICIPANTS

ARTICLE 7 — BENEFICIARIES

The beneficiaries, as signatories of the Agreement, are fully responsible towards the granting authority for implementing it and for complying with all its obligations.

They must implement the Agreement to their best abilities, in good faith and in accordance with all the obligations and terms and conditions it sets out.

They must have the appropriate resources to implement the action and implement the action under their own responsibility and in accordance with Article 11. If they rely on affiliated entities or other participants (see Articles 8 and 9), they retain sole responsibility towards the granting authority and the other beneficiaries.

They are jointly responsible for the *technical* implementation of the action. If one of the beneficiaries fails to implement their part of the action, the other beneficiaries must ensure that this part is implemented by someone else (without being entitled to an increase of the maximum grant amount and subject to an amendment; see Article 39). The *financial* responsibility of each beneficiary in case of recoveries is governed by Article 22.

The beneficiaries (and their action) must remain eligible under the EU programme funding the grant for the entire duration of the action. Unit contributions will be eligible only as long as the beneficiary and the action are eligible.

The **internal roles and responsibilities** of the beneficiaries are divided as follows:

(a) Each beneficiary must:

(i) keep information stored in the Portal Participant Register up to date (see Article 19)

(ii) inform the granting authority (and the other beneficiaries) immediately of any events or circumstances likely to affect significantly or delay the implementation of the action (see Article 19)

(iii) submit to the coordinator in good time:

- the prefinancing guarantees (if required; see Article 23)
- the financial statements and certificates on the financial statements (CFS) (if required; see Articles 21 and 24.2 and Data Sheet, Point 4.3)
- the contribution to the deliverables and technical reports (see Article 21)

- any other documents or information required by the granting authority under the Agreement

(iv) submit via the Portal data and information related to the participation of their affiliated entities.

(b) The coordinator must:

(i) monitor that the action is implemented properly (see Article 11)

(ii) act as the intermediary for all communications between the consortium and the granting authority, unless the Agreement or granting authority specifies otherwise, and in particular:

- submit the prefinancing guarantees to the granting authority (if any)
- request and review any documents or information required and verify their quality and completeness before passing them on to the granting authority
- submit the deliverables and reports to the granting authority
- inform the granting authority about the payments made to the other beneficiaries (report on the distribution of payments; if required, see Articles 22 and 32)

(iii) distribute the payments received from the granting authority to the other beneficiaries without unjustified delay (see Article 22).

The coordinator may not delegate or subcontract the above-mentioned tasks to any other beneficiary or third party (including affiliated entities).

However, coordinators which are public bodies may delegate the tasks set out in Point (b)(ii) last indent and (iii) above to entities with 'authorisation to administer' which they have created or which are controlled by or affiliated to them. In this case, the coordinator retains sole responsibility for the payments and for compliance with the obligations under the Agreement.

Moreover, coordinators which are 'sole beneficiaries'[12] (or similar, such as European research infrastructure consortia (ERICs)) may delegate the tasks set out in Point (b)(i) to (iii) above to one of their members. The coordinator retains sole responsibility for compliance with the obligations under the Agreement.

The beneficiaries must have **internal arrangements** regarding their operation and co-ordination, to ensure that the action is implemented properly.

If required by the granting authority (see Data Sheet, Point 1), these arrangements must be set out in a written **consortium agreement** between the beneficiaries, covering for instance:

- the internal organisation of the consortium

[12] For the definition, see Article 187(2) EU Financial Regulation 2018/1046: "Where several entities satisfy the criteria for being awarded a grant and together form one entity, that entity may be treated as the **sole beneficiary**, including where it is specifically established for the purpose of implementing the action financed by the grant."

- the management of access to the Portal
- different distribution keys for the payments and financial responsibilities in case of recoveries (if any)
- additional rules on rights and obligations related to background and results (see Article 16)
- settlement of internal disputes
- liability, indemnification and confidentiality arrangements between the beneficiaries.

The internal arrangements must not contain any provision contrary to this Agreement.

ARTICLE 8 — AFFILIATED ENTITIES

Not applicable

ARTICLE 9 — OTHER PARTICIPANTS INVOLVED IN THE ACTION

9.1 Associated partners

Not applicable

9.2 Third parties giving in-kind contributions to the action

Other third parties may give in-kind contributions to the action (i.e. personnel, equipment, other goods, works and services, etc. which are free-of-charge) if necessary for the implementation.

Third parties giving in-kind contributions do not implement any action tasks. They may not charge contributions to the action (no unit contributions) and their costs are considered entirely covered by the unit contributions paid to the beneficiaries.

The third parties and their in-kind contributions should be set out in Annex 1.

9.3 Subcontractors

Subcontractors may participate in the action, if necessary for the implementation.

Subcontractors must implement their action tasks in accordance with Article 11. The beneficiaries' costs for subcontracting are considered entirely covered by the unit contributions (irrespective of the actual subcontracting costs incurred, if any).

The beneficiaries must ensure that their contractual obligations under Articles 11 (proper implementation), 12 (conflict of interest), 13 (confidentiality and security), 14 (ethics), 17.2 (visibility), 18 (specific rules for carrying out action), 19 (information) and 20 (record-keeping) also apply to the subcontractors.

The beneficiaries must ensure that the bodies mentioned in Article 25 (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.) can exercise their rights also towards the subcontractors.

9.4 Recipients of financial support to third parties

If the action includes providing financial support to third parties (e.g. grants, prizes or similar forms of support), the beneficiaries must ensure that their contractual obligations under Articles 12 (conflict of interest), 13 (confidentiality and security), 14 (ethics), 17.2 (visibility), 18 (specific rules for carrying out action), 19 (information) and 20 (record-keeping)also apply to the third parties receiving the support (recipients).

The beneficiaries must also ensure that the bodies mentioned in Article 25 (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.) can exercise their rights also towards the recipients.

ARTICLE 10 — PARTICIPANTS WITH SPECIAL STATUS

10.1 Non-EU participants

Participants which are established in a non-EU country (if any) undertake to comply with their obligations under the Agreement and:

- to respect general principles (including fundamental rights, values and ethical principles, environmental and labour standards, rules on classified information, intellectual property rights, visibility of funding and protection of personal data)
- for the submission of certificates under Article 24: to use qualified external auditors which are independent and comply with comparable standards as those set out in EU Directive 2006/43/EC[13]
- for the controls under Article 25: to allow for checks, reviews, audits and investigations (including on-the-spot checks, visits and inspections) by the bodies mentioned in that Article (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.).

Special rules on dispute settlement apply (see Data Sheet, Point 5).

10.2 Participants which are international organisations

Participants which are international organisations (IOs; if any) undertake to comply with their obligations under the Agreement and:

- to respect general principles (including fundamental rights, values and ethical principles, environmental and labour standards, rules on classified information, intellectual property rights, visibility of funding and protection of personal data)
- for the submission of certificates under Article 24: to use either independent public officers or external auditors which comply with comparable standards as those set out in EU Directive 2006/43/EC
- for the controls under Article 25: to allow for the checks, reviews, audits and investigations by the bodies mentioned in that Article, taking into account the specific agreements concluded by them and the EU (if any).

[13] Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts or similar national regulations (OJ L 157, 9.6.2006, p. 87).

For such participants, nothing in the Agreement will be interpreted as a waiver of their privileges or immunities, as accorded by their constituent documents or international law.

Special rules on applicable law and dispute settlement apply (see Article 43 and Data Sheet, Point 5).

10.3 Pillar-assessed participants

Pillar-assessed participants (if any) may rely on their own systems, rules and procedures, in so far as they have been positively assessed and do not call into question the decision awarding the grant or breach the principle of equal treatment of applicants or beneficiaries.

'Pillar-assessment' means a review by the European Commission on the systems, rules and procedures which participants use for managing EU grants (in particular internal control system, accounting system, external audits, financing of third parties, rules on recovery and exclusion, information on recipients and protection of personal data; see Article 154 EU Financial Regulation 2018/1046).

Participants with a positive pillar assessment may rely on their own systems, rules and procedures, in particular for:

- record-keeping (Article 20): may be done in accordance with internal standards, rules and procedures
- currency conversion for financial statements (Article 21): may be done in accordance with usual accounting practices
- guarantees (Article 23): for public law bodies, prefinancing guarantees are not needed
- certificates (Article 24):
    - certificates on the financial statements (CFS): may be provided by their regular internal or external auditors and in accordance with their internal financial regulations and procedures
    - certificates on usual accounting practices (CoMUC): are not needed if those practices are covered by an ex-ante assessment

and use the following specific rules, for:

- recoveries (Article 22): in case of financial support to third parties, there will be no recovery if the participant has done everything possible to retrieve the undue amounts from the third party receiving the support (including legal proceedings) and non-recovery is not due to an error or negligence on its part
- checks, reviews, audits and investigations by the EU (Article 25): will be conducted taking into account the rules and procedures specifically agreed between them and the framework agreement (if any)
- impact evaluation (Article 26): will be conducted in accordance with the participant's internal rules and procedures and the framework agreement (if any)
- grant agreement suspension (Article 31): certain costs incurred during grant suspension are eligible (notably, minimum costs necessary for a possible resumption of the action and costs

relating to contracts which were entered into before the pre-information letter was received and which could not reasonably be suspended, reallocated or terminated on legal grounds)

- grant agreement termination (Article 32): the final grant amount and final payment will be calculated taking into account also costs relating to contracts due for execution only after termination takes effect, if the contract was entered into before the pre-information letter was received and could not reasonably be terminated on legal grounds

- liability for damages (Article 33.2): the granting authority must be compensated for damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement only if the damage is due to an infringement of the participant's internal rules and procedures or due to a violation of third parties' rights by the participant or one of its employees or individual for whom the employees are responsible.

Participants whose pillar assessment covers procurement and granting procedures may also do purchases, subcontracting and financial support to third parties (Article 6.2) in accordance with their internal rules and procedures for purchases, subcontracting and financial support.

Participants whose pillar assessment covers data protection rules may rely on their internal standards, rules and procedures for data protection (Article 15).

The participants may however not rely on provisions which would breach the principle of equal treatment of applicants or beneficiaries or call into question the decision awarding the grant, such as in particular:

- eligibility (Article 6)

- consortium roles and set-up (Articles 7-9)

- security and ethics (Articles 13, 14)

- IPR (including background and results, access rights and rights of use), communication, dissemination and visibility (Articles 16 and 17)

- information obligation (Article 19)

- payment, reporting and amendments (Articles 21, 22 and 39)

- rejections, reductions, suspensions and terminations (Articles 27, 28, 29-32)

If the pillar assessment was subject to remedial measures, reliance on the internal systems, rules and procedures is subject to compliance with those remedial measures.

Participants whose assessment has not yet been updated to cover (the new rules on) data protection may rely on their internal systems, rules and procedures, provided that they ensure that personal data is:

- processed lawfully, fairly and in a transparent manner in relation to the data subject

- collected for specified, explicit and legitimate purposes and not further processed in a manner that is incompatible with those purposes

- adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed

- accurate and, where necessary, kept up to date

- kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the data is processed and

- processed in a manner that ensures appropriate security of the personal data.

Participants must inform the coordinator without delay of any changes to the systems, rules and procedures that were part of the pillar assessment. The coordinator must immediately inform the granting authority.

Pillar-assessed participants that have also concluded a framework agreement with the EU, may moreover — under the same conditions as those above (i.e. not call into question the decision awarding the grant or breach the principle of equal treatment of applicants or beneficiaries) — rely on the provisions set out in that framework agreement.

SECTION 2 RULES FOR CARRYING OUT THE ACTION

ARTICLE 11 — PROPER IMPLEMENTATION OF THE ACTION

11.1 Obligation to properly implement the action

The beneficiaries must implement the action as described in Annex 1 and in compliance with the provisions of the Agreement, the call conditions and all legal obligations under applicable EU, international and national law.

11.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 12 — CONFLICT OF INTERESTS

12.1 Conflict of interests

The beneficiaries must take all measures to prevent any situation where the impartial and objective implementation of the Agreement could be compromised for reasons involving family, emotional life, political or national affinity, economic interest or any other direct or indirect interest (‘conflict of interests’).

They must formally notify the granting authority without delay of any situation constituting or likely to lead to a conflict of interests and immediately take all the necessary steps to rectify this situation.

The granting authority may verify that the measures taken are appropriate and may require additional measures to be taken by a specified deadline.

12.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28) and the grant or the beneficiary may be terminated (see Article 32).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 13 — CONFIDENTIALITY AND SECURITY

13.1 Sensitive information

The parties must keep confidential any data, documents or other material (in any form) that is identified as sensitive in writing ('sensitive information') — during the implementation of the action and for at least until the time-limit set out in the Data Sheet (see Point 6).

If a beneficiary requests, the granting authority may agree to keep such information confidential for a longer period.

Unless otherwise agreed between the parties, they may use sensitive information only to implement the Agreement.

The beneficiaries may disclose sensitive information to their personnel or other participants involved in the action only if they:

(a) need to know it in order to implement the Agreement and

(b) are bound by an obligation of confidentiality.

The granting authority may disclose sensitive information to its staff and to other EU institutions and bodies.

It may moreover disclose sensitive information to third parties, if:

(a) this is necessary to implement the Agreement or safeguard the EU financial interests and

(b) the recipients of the information are bound by an obligation of confidentiality.

The confidentiality obligations no longer apply if:

(a) the disclosing party agrees to release the other party

(b) the information becomes publicly available, without breaching any confidentiality obligation

(c) the disclosure of the sensitive information is required by EU, international or national law.

Specific confidentiality rules (if any) are set out in Annex 5.

13.2 Classified information

The parties must handle classified information in accordance with the applicable EU, international or national law on classified information (in particular, Decision 2015/444[14] and its implementing rules).

Deliverables which contain classified information must be submitted according to special procedures agreed with the granting authority.

Action tasks involving classified information may be subcontracted only after explicit approval (in writing) from the granting authority.

Classified information may not be disclosed to any third party (including participants involved in the action implementation) without prior explicit written approval from the granting authority.

Specific security rules (if any) are set out in Annex 5.

13.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 14 — ETHICS AND VALUES

14.1 Ethics

The action must be carried out in line with the highest ethical standards and the applicable EU, international and national law on ethical principles.

Specific ethics rules (if any) are set out in Annex 5.

14.2 Values

The beneficiaries must commit to and ensure the respect of basic EU values (such as respect for human dignity, freedom, democracy, equality, the rule of law and human rights, including the rights of minorities).

Specific rules on values (if any) are set out in Annex 5.

14.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 15 — DATA PROTECTION

15.1 Data processing by the granting authority

[14] Commission Decision 2015/444/EC, Euratom of 13 March 2015 on the security rules for protecting EU classified information (OJ L 72, 17.3.2015, p. 53).

Any personal data under the Agreement will be processed under the responsibility of the data controller of the granting authority in accordance with and for the purposes set out in the Portal Privacy Statement.

For grants where the granting authority is the European Commission, an EU regulatory or executive agency, joint undertaking or other EU body, the processing will be subject to Regulation 2018/1725[15].

15.2 Data processing by the beneficiaries

The beneficiaries must process personal data under the Agreement in compliance with the applicable EU, international and national law on data protection (in particular, Regulation 2016/679[16]).

They must ensure that personal data is:

- processed lawfully, fairly and in a transparent manner in relation to the data subjects
- collected for specified, explicit and legitimate purposes and not further processed in a manner that is incompatible with those purposes
- adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed
- accurate and, where necessary, kept up to date
- kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the data is processed and
- processed in a manner that ensures appropriate security of the data.

The beneficiaries may grant their personnel access to personal data only if it is strictly necessary for implementing, managing and monitoring the Agreement. The beneficiaries must ensure that the personnel is under a confidentiality obligation.

The beneficiaries must inform the persons whose data are transferred to the granting authority and provide them with the Portal Privacy Statement.

15.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 16 — INTELLECTUAL PROPERTY RIGHTS (IPR) — BACKGROUND AND RESULTS —ACCESS RIGHTS AND RIGHTS OF USE

[15] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC (OJ L 295, 21.11.2018, p. 39).

[16] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (‘GDPR’) (OJ L 119, 4.5.2016, p. 1).

16.1 Background and access rights to background

The beneficiaries must give each other and the other participants access to the background identified as needed for implementing the action, subject to any specific rules in Annex 5.

'Background' means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that is:

(a) held by the beneficiaries before they acceded to the Agreement and

(b) needed to implement the action or exploit the results.

If background is subject to rights of a third party, the beneficiary concerned must ensure that it is able to comply with its obligations under the Agreement.

16.2 Ownership of results

The granting authority does not obtain ownership of the results produced under the action.

'Results' means any tangible or intangible effect of the action, such as data, know-how or information, whatever its form or nature, whether or not it can be protected, as well as any rights attached to it, including intellectual property rights.

16.3 Rights of use of the granting authority on materials, documents and information received for policy, information, communication, dissemination and publicity purposes

The granting authority has the right to use non-sensitive information relating to the action and materials and documents received from the beneficiaries (notably summaries for publication, deliverables, as well as any other material, such as pictures or audio-visual material, in paper or electronic form) for policy, information, communication, dissemination and publicity purposes — during the action or afterwards.

The right to use the beneficiaries' materials, documents and information is granted in the form of a royalty-free, non-exclusive and irrevocable licence, which includes the following rights:

(a) **use for its own purposes** (in particular, making them available to persons working for the granting authority or any other EU service (including institutions, bodies, offices, agencies, etc.) or EU Member State institution or body; copying or reproducing them in whole or in part, in unlimited numbers; and communication through press information services)

(b) **distribution to the public** (in particular, publication as hard copies and in electronic or digital format, publication on the internet, as a downloadable or non-downloadable file, broadcasting by any channel, public display or presentation, communicating through press information services, or inclusion in widely accessible databases or indexes)

(c) **editing or redrafting** (including shortening, summarising, inserting other elements (e.g. meta-data, legends, other graphic, visual, audio or text elements), extracting parts (e.g. audio or video files), dividing into parts, use in a compilation)

(d) **translation**

(e) **storage** in paper, electronic or other form

(f) **archiving**, in line with applicable document-management rules

(g) the right to authorise **third parties** to act on its behalf or sub-license to third parties the modes of use set out in Points (b), (c), (d) and (f), if needed for the information, communication and publicity activity of the granting authority

(h) **processing**, analysing, aggregating the materials, documents and information received and **producing derivative works**.

The rights of use are granted for the whole duration of the industrial or intellectual property rights concerned.

If materials or documents are subject to moral rights or third party rights (including intellectual property rights or rights of natural persons on their image and voice), the beneficiaries must ensure that they comply with their obligations under this Agreement (in particular, by obtaining the necessary licences and authorisations from the rights holders concerned).

Where applicable, the granting authority will insert the following information:

"© – [year] – [name of the copyright owner]. All rights reserved. Licensed to the [name of granting authority] under conditions."

16.4 Specific rules on IPR, results and background

Specific rules regarding intellectual property rights, results and background (if any) are set out in Annex 5.

16.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such a breach may also lead to other measures described in Chapter 5.

ARTICLE 17 — COMMUNICATION, DISSEMINATION AND VISIBILITY

17.1 Communication — Dissemination — Promoting the action

Unless otherwise agreed with the granting authority, the beneficiaries must promote the action and its results by providing targeted information to multiple audiences (including the media and the public), in accordance with Annex 1 and in a strategic, coherent and effective manner.

Before engaging in a communication or dissemination activity expected to have a major media impact, the beneficiaries must inform the granting authority.

17.2 Visibility — European flag and funding statement

Unless otherwise agreed with the granting authority, communication activities of the beneficiaries related to the action (including media relations, conferences, seminars, information material, such as brochures, leaflets, posters, presentations, etc., in electronic form, via traditional or social media, etc.), dissemination activities and any infrastructure, equipment, vehicles, supplies or major result funded

by the grant must acknowledge EU support and display the European flag (emblem) and funding statement (translated into local languages, where appropriate):

The emblem must remain distinct and separate and cannot be modified by adding other visual marks, brands or text.

Apart from the emblem, no other visual identity or logo may be used to highlight the EU support.

When displayed in association with other logos (e.g. of beneficiaries or sponsors), the emblem must be displayed at least as prominently and visibly as the other logos.

For the purposes of their obligations under this Article, the beneficiaries may use the emblem without first obtaining approval from the granting authority. This does not, however, give them the right to exclusive use. Moreover, they may not appropriate the emblem or any similar trademark or logo, either by registration or by any other means.

17.3 Quality of information — Disclaimer

Any communication or dissemination activity related to the action must use factually accurate information.

Moreover, it must indicate the following disclaimer (translated into local languages where appropriate):

> "Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [name of the granting authority]. Neither the European Union nor the granting authority can be held responsible for them."

17.4 Specific communication, dissemination and visibility rules

Specific communication, dissemination and visibility rules (if any) are set out in Annex 5.

17.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 18 — SPECIFIC RULES FOR CARRYING OUT THE ACTION

18.1 Specific rules for carrying out the action

Specific rules for implementing the action (if any) are set out in Annex 5.

18.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such a breach may also lead to other measures described in Chapter 5.

SECTION 3 GRANT ADMINISTRATION

ARTICLE 19 — GENERAL INFORMATION OBLIGATIONS

19.1 Information requests

The beneficiaries must provide — during the action or afterwards and in accordance with Article 7 — any information requested in order to verify eligibility of the unit contributions declared, proper implementation of the action and compliance with the other obligations under the Agreement.

The information provided must be accurate, precise and complete and in the format requested, including electronic format.

19.2 Participant Register data updates

The beneficiaries must keep — at all times, during the action or afterwards — their information stored in the Portal Participant Register up to date, in particular, their name, address, legal representatives, legal form and organisation type.

19.3 Information about events and circumstances which impact the action

The beneficiaries must immediately inform the granting authority (and the other beneficiaries) of any of the following:

(a) **events** which are likely to affect or delay the implementation of the action or affect the EU's financial interests, in particular:

(i) changes in their legal, financial, technical, organisational or ownership situation (including changes linked to one of the exclusion grounds listed in the declaration of honour signed before grant signature)

(ii) linked action information: not applicable

(b) **circumstances** affecting:

(i) the decision to award the grant or

(ii) compliance with requirements under the Agreement.

19.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 20 — RECORD-KEEPING

20.1 Keeping records and supporting documents

The beneficiaries must — at least until the time-limit set out in the Data Sheet (see Point 6) — keep records and other supporting documents to prove the proper implementation of the action in line with the accepted standards in the respective field (if any).

In addition, the beneficiaries must — for the same period — keep adequate records and supporting documents to prove the number of units declared; beneficiaries do not need to keep specific records on the actual costs incurred.

The records and supporting documents must be made available upon request (see Article 19) or in the context of checks, reviews, audits or investigations (see Article 25).

If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Article 25), the beneficiaries must keep these records and other supporting documentation until the end of these procedures.

The beneficiaries must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The granting authority may accept non-original documents if they offer a comparable level of assurance.

20.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, unit contributions insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 27), and the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 21 — REPORTING

21.1 Continuous reporting

The beneficiaries must continuously report on the progress of the action (e.g. **deliverables,**

milestones, outputs/outcomes, critical risks, indicators, etc; if any), in the Portal Continuous Reporting tool and in accordance with the timing and conditions it sets out (as agreed with the granting authority).

Standardised deliverables (e.g. progress reports not linked to payments, reports on cumulative expenditure, special reports, etc; if any) must be submitted using the templates published on the Portal.

21.2 Periodic reporting: Technical reports and financial statements

In addition, the beneficiaries must provide reports to request payments, in accordance with the schedule and modalities set out in the Data Sheet (see Point 4.2):

- for additional prefinancings (if any): an **additional prefinancing report**
- for interim payments (if any) and the final payment: a **periodic report**.

The prefinancing and periodic reports include a technical and financial part.

The technical part includes an overview of the action implementation. It must be prepared using the template available in the Portal Periodic Reporting tool.

The financial part of the additional prefinancing report includes a statement on the use of the previous prefinancing payment.

The financial part of the periodic report includes:

- the financial statements (individual and consolidated; for all beneficiaries/affiliated entities)
- the explanation on the use of resources (or detailed cost reporting table, if required)
- the certificates on the financial statements (CFS): not applicable.

The **financial statements** must detail the contributions for the units implemented in the reporting period.

Unit contributions which are not declared in a financial statement will not be taken into account by the granting authority.

By signing the financial statements (directly in the Portal Periodic Reporting tool), the beneficiaries confirm that:

- the information provided is complete, reliable and true
- the unit contributions declared are eligible (see Article 6)
- the contributions can be substantiated by adequate records and supporting documents (see Article 20) that will be produced upon request (see Article 19) or in the context of checks, reviews, audits and investigations (see Article 25)

Beneficiaries will have to submit also the financial statements of their affiliated entities (if any). In case of recoveries (see Article 22), beneficiaries will be held responsible also for the financial statements of their affiliated entities.

21.3 Currency for financial statements and conversion into euros

The financial statements must be drafted in euro.

21.4 Reporting language

The reporting must be in the language of the Agreement, unless otherwise agreed with the granting authority (see Data Sheet, Point 4.2).

21.5 Consequences of non-compliance

If a report submitted does not comply with this Article, the granting authority may suspend the payment deadline (see Article 29) and apply other measures described in Chapter 5.

If the coordinator breaches its reporting obligations, the granting authority may terminate the grant or the coordinator's participation (see Article 32) or apply other measures described in Chapter 5.

ARTICLE 22 — PAYMENTS AND RECOVERIES — CALCULATION OF AMOUNTS DUE

22.1 Payments and payment arrangements

Payments will be made in accordance with the schedule and modalities set out in the Data Sheet (see Point 4.2).

They will be made in euro to the bank account indicated by the coordinator (see Data Sheet, Point 4.2) and must be distributed without unjustified delay (restrictions may apply to distribution of the initial prefinancing payment; see Data Sheet, Point 4.2).

Payments to this bank account will discharge the granting authority from its payment obligation.

The cost of payment transfers will be borne as follows:

- the granting authority bears the cost of transfers charged by its bank
- the beneficiary bears the cost of transfers charged by its bank
- the party causing a repetition of a transfer bears all costs of the repeated transfer.

Payments by the granting authority will be considered to have been carried out on the date when they are debited to its account.

22.2 Recoveries

Recoveries will be made, if — at beneficiary termination, final payment or afterwards — it turns out that the granting authority has paid too much and needs to recover the amounts undue.

Each beneficiary's financial responsibility in case of recovery is in principle limited to their own debt and undue amounts of their affiliated entities.

In case of enforced recoveries (see Article 22.4), affiliated entities will be held liable for repaying debts of their beneficiaries, if required by the granting authority (see Data Sheet, Point 4.4).

22.3 Amounts due

22.3.1 Prefinancing payments

The aim of the prefinancing is to provide the beneficiaries with a float.

It remains the property of the EU until the final payment.

For **initial prefinancings** (if any), the amount due, schedule and modalities are set out in the Data Sheet (see Point 4.2).

For **additional prefinancings** (if any), the amount due, schedule and modalities are also set out in the Data Sheet (see Point 4.2). However, if the statement on the use of the previous prefinancing payment shows that less than 70% was used, the amount set out in the Data Sheet will be reduced by the difference between the 70% threshold and the amount used.

The contribution to the Mutual Insurance Mechanism will be retained from the prefinancing payments (at the rate and in accordance with the modalities set out in the Data Sheet, see Point 4.2) and transferred to the Mechanism.

Prefinancing payments (or parts of them) may be offset (without the beneficiaries' consent) against amounts owed by a beneficiary to the granting authority — up to the amount due to that beneficiary.

For grants where the granting authority is the European Commission or an EU executive agency, offsetting may also be done against amounts owed to other Commission services or executive agencies.

Payments will not be made if the payment deadline or payments are suspended (see Articles 29 and 30).

22.3.2 Amount due at beneficiary termination — Recovery

At beneficiary termination there will be no payment, but the grant must be provisionally closed for the beneficiary which leaves the consortium (and the affiliated entities which had to end their participation together with the beneficiary, if any).

Payments (if any) will be made with the next interim or final payment.

The **amount due** will be calculated in the following step:

Step 1 — Calculation of the total accepted EU contribution

Step 1 — Calculation of the total accepted EU contribution

The granting authority will first calculate the 'accepted EU contribution' for the beneficiary for all reporting periods, by calculating the unit contributions for the accepted units.

After that, the granting authority will take into account grant reductions (if any). The resulting amount is the 'total accepted EU contribution' for the beneficiary.

The **balance** is then calculated by deducting the payments received (if any; see report on the distribution of payments in Article 32), from the total accepted EU contribution:

{total accepted EU contribution for the beneficiary

minus

{prefinancing and interim payments received (if any)}}.

If the balance is **positive**, the amount will be included in the next interim or final payment to the consortium.

If the balance is **negative**, it will be **recovered** in accordance with the following procedure:

The granting authority will send a **pre-information letter** to the beneficiary concerned:

- formally notifying the intention to recover, the amount due, the amount to be recovered and the reasons why and
- requesting observations within 30 days of receiving notification.

If no observations are submitted (or the granting authority decides to pursue recovery despite the observations it has received), it will confirm the amount to be recovered and ask this amount to be paid to the coordinator (**confirmation letter**).

If payment is not made to the coordinator by the date specified in the confirmation letter, the granting authority may call on the Mutual Insurance Mechanism to intervene, if continuation of the action is guaranteed and the conditions set out in the rules governing the Mechanism are met.

In this case, it will send a **beneficiary recovery letter**, together with a **debit note** with the terms and date for payment.

The debit note for the beneficiary will include the amount calculated for the affiliated entities which also had to end their participation (if any).

If payment is not made by the date specified in the debit note, the granting authority will **enforce recovery** in accordance with Article 22.4.

The amounts will later on also be taken into account for the next interim or final payment.

22.3.3 Interim payments

Interim payments reimburse the eligible contributions claimed for the units implemented during the reporting periods (if any).

Interim payments (if any) will be made in accordance with the schedule and modalities set out the Data Sheet (see Point 4.2).

Payment is subject to the approval of the periodic report. Its approval does not imply recognition of compliance, authenticity, completeness or correctness of its content.

The **interim payment** will be calculated by the granting authority in the following steps:

Step 1 — Calculation of the total accepted EU contribution

Step 2 — Limit to the interim payment ceiling

Step 1 — Calculation of the total accepted EU contribution

The granting authority will first calculate the 'accepted EU contribution' for the action for the reporting period, by calculating the unit contributions for the accepted units.

After that, the granting authority will take into account grant reductions from beneficiary termination (if any). The resulting amount is the 'total accepted EU contribution'.

Step 2 — Limit to the interim payment ceiling

The resulting amount is then capped to ensure that the total amount of prefinancing and interim payments (if any) does not exceed the interim payment ceiling set out in the Data Sheet (see Point 4.2).

Interim payments (or parts of them) may be offset (without the beneficiaries' consent) against amounts owed by a beneficiary to the granting authority — up to the amount due to that beneficiary.

For grants where the granting authority is the European Commission or an EU executive agency, offsetting may also be done against amounts owed to other Commission services or executive agencies.

Payments will not be made if the payment deadline or payments are suspended (see Articles 29 and 30).

22.3.4 Final payment — Final grant amount — Revenues and Profit — Recovery

The final payment (payment of the balance) reimburses the eligible contributions claimed for the remaining units implemented (if any).

The final payment will be made in accordance with the schedule and modalities set out in the Data Sheet (see Point 4.2).

Payment is subject to the approval of the final periodic report. Its approval does not imply recognition of compliance, authenticity, completeness or correctness of its content.

The **final grant amount for the action** will be calculated in the following steps:

Step 1 — Calculation of the total accepted EU contribution

Step 2 — Limit to the maximum grant amount

Step 3 — Reduction due to the no-profit rule

Step 1 — Calculation of the total accepted EU contribution

The granting authority will first calculate the 'accepted EU contribution' for the action for all reporting periods, by calculating the unit contributions for the accepted units.

After that, the granting authority will take into account grant reductions (if any). The resulting amount is the 'total accepted EU contribution'.

Step 2 — Limit to the maximum grant amount

If the resulting amount is higher than the maximum grant amount set out in Article 5.2, it will be limited to the latter.

Step 3 — Reduction due to the no-profit rule

Not applicable

The **balance** (final payment) is then calculated by deducting the total amount of prefinancing and interim payments already made (if any), from the final grant amount:

{final grant amount

minus

{prefinancing and interim payments made (if any)}}.

If the balance is **positive**, it will be **paid** to the coordinator.

The amount retained for the Mutual Insurance Mechanism (see above) will be released and **paid** to the coordinator (in accordance with the rules governing the Mechanism).

The final payment (or part of it) may be offset (without the beneficiaries' consent) against amounts owed by a beneficiary to the granting authority — up to the amount due to that beneficiary.

For grants where the granting authority is the European Commission or an EU executive agency, offsetting may also be done against amounts owed to other Commission services or executive agencies.

Payments will not be made if the payment deadline or payments are suspended (see Articles 29 and 30).

If — despite the release of the Mutual Insurance Mechanism contribution — the balance is **negative**, it will be **recovered** in accordance with the following procedure:

The granting authority will send a **pre-information letter** to the coordinator:

- formally notifying the intention to recover, the final grant amount, the amount to be recovered and the reasons why
- requesting a report on the distribution of payments to the beneficiaries within 30 days of receiving notification and
- requesting observations within 30 days of receiving notification.

If no observations are submitted (or the granting authority decides to pursue recovery despite the observations it has received) and the coordinator has submitted the report on the distribution of payments, it will calculate the **share of the debt per beneficiary**, by:

(a) identifying the beneficiaries for which the amount calculated as follows is negative:

{{{total accepted EU contribution for the beneficiary

divided by

total accepted EU contribution for the action}

multiplied by

final grant amount for the action},

minus

{prefinancing and interim payments received by the beneficiary (if any)}}

and

(b) dividing the debt:

{{amount calculated according to point (a) for the beneficiary concerned

divided by

the sum of the amounts calculated according to point (a) for all the beneficiaries identified according to point (a)}

multiplied by

the amount to be recovered}.

and confirm the amount to be recovered from each beneficiary concerned (**confirmation letter**), together with **debit notes** with the terms and date for payment.

The debit notes for beneficiaries will include the amounts calculated for their affiliated entities (if any).

If the coordinator has not submitted the report on the distribution of payments, the granting authority will **recover** the full amount from the coordinator (**confirmation letter** and **debit note** with the terms and date for payment).

If payment is not made by the date specified in the debit note, the granting authority will **enforce recovery** in accordance with Article 22.4.

22.3.5 Audit implementation after final payment — Revised final grant amount — Recovery

If — after the final payment (in particular, after checks, reviews, audits or investigations; see Article 25) — the granting authority rejects unit contributions (see Article 27) or reduces the grant (see Article 28), it will calculate the **revised final grant amount** for the beneficiary concerned.

The **beneficiary revised final grant amount** will be calculated in the following step:

Step 1 — Calculation of the revised total accepted EU contribution

Step 1 — Calculation of the revised total accepted EU contribution

The granting authority will first calculate the ‘revised accepted EU contribution’ for the beneficiary, by calculating the ‘revised accepted contributions’.

After that, it will take into account grant reductions (if any). The resulting ‘revised total accepted EU contribution’ is the beneficiary revised final grant amount.

If the revised final grant amount is lower than the beneficiary’s final grant amount (i.e. its share in the final grant amount for the action), it will be **recovered** in accordance with the following procedure:

The **beneficiary final grant amount** (i.e. share in the final grant amount for the action) is calculated as follows:

{{total accepted EU contribution for the beneficiary

divided by

total accepted EU contribution for the action}

multiplied by

final grant amount for the action}.

The granting authority will send a **pre-information letter** to the beneficiary concerned:

- formally notifying the intention to recover, the amount to be recovered and the reasons why and
- requesting observations within 30 days of receiving notification.

If no observations are submitted (or the granting authority decides to pursue recovery despite the observations it has received), it will confirm the amount to be recovered (**confirmation letter**), together with a **debit note** with the terms and the date for payment.

Recoveries against affiliated entities (if any) will be handled through their beneficiaries.

If payment is not made by the date specified in the debit note, the granting authority will **enforce recovery** in accordance with Article 22.4.

22.4 Enforced recovery

If payment is not made by the date specified in the debit note, the amount due will be recovered:

(a) by offsetting the amount — without the coordinator or beneficiary's consent — against any amounts owed to the coordinator or beneficiary by the granting authority.

In exceptional circumstances, to safeguard the EU financial interests, the amount may be offset before the payment date specified in the debit note.

For grants where the granting authority is the European Commission or an EU executive agency, debts may also be offset against amounts owed by other Commission services or executive agencies.

(b) financial guarantee(s): not applicable

(c) joint and several liability of beneficiaries: not applicable

(d) by holding affiliated entities jointly and severally liable (if any, see Data Sheet, Point 4.4)

(e) by taking legal action (see Article 43) or, provided that the granting authority is the European Commission or an EU executive agency, by adopting an enforceable decision under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 100(2) of EU Financial Regulation 2018/1046.

If the Mutual Insurance Mechanism was called on by the granting authority to intervene, recovery will be continued in the name of the Mutual Insurance Mechanism. If two debit notes were sent, the second

one (in the name of the Mutual Insurance Mechanism) will be considered to replace the first one (in the name of the granting authority). Where the MIM intervened, offsetting, enforceable decisions or any other of the above-mentioned forms of enforced recovery may be used mutatis mutandis.

The amount to be recovered will be increased by **late-payment interest** at the rate set out in Article 22.5, from the day following the payment date in the debit note, up to and including the date the full payment is received.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2015/2366[17] applies.

For grants where the granting authority is an EU executive agency, enforced recovery by offsetting or enforceable decision will be done by the services of the European Commission (see also Article 43).

22.5 Consequences of non-compliance

22.5.1 If the granting authority does not pay within the payment deadlines (see above), the beneficiaries are entitled to **late-payment interest** at the rate applied by the European Central Bank (ECB) for its main refinancing operations in euros ('reference rate'), plus the rate specified in the Data Sheet (Point 4.2). The reference rate is the rate in force on the first day of the month in which the payment deadline expires, as published in the C series of the *Official Journal of the European Union*.

If the late-payment interest is lower than or equal to EUR 200, it will be paid to the coordinator only on request submitted within two months of receiving the late payment.

Late-payment interest is not due if all beneficiaries are EU Member States (including regional and local government authorities or other public bodies acting on behalf of a Member State for the purpose of this Agreement).

If payments or the payment deadline are suspended (see Articles 29 and 30), payment will not be considered as late.

Late-payment interest covers the period running from the day following the due date for payment (see above), up to and including the date of payment.

Late-payment interest is not considered for the purposes of calculating the final grant amount.

22.5.2 If the coordinator breaches any of its obligations under this Article, the grant may be reduced (see Article 28) and the grant or the coordinator may be terminated (see Article 32).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 23 — GUARANTEES

Not applicable

[17] Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No 1093/2010, and repealing Directive 2007/64/EC (OJ L 337, 23.12.2015, p. 35).

ARTICLE 24 — CERTIFICATES

Not applicable

ARTICLE 25 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS

25.1 Granting authority checks, reviews and audits

25.1.1 Internal checks

The granting authority may — during the action or afterwards — check the proper implementation of the action and compliance with the obligations under the Agreement, including assessing unit contributions, deliverables and reports.

25.1.2 Project reviews

The granting authority may carry out reviews on the proper implementation of the action and compliance with the obligations under the Agreement (general project reviews or specific issues reviews).

Such project reviews may be started during the implementation of the action and until the time-limit set out in the Data Sheet (see Point 6). They will be formally notified to the coordinator or beneficiary concerned and will be considered to start on the date of the notification.

If needed, the granting authority may be assisted by independent, outside experts. If it uses outside experts, the coordinator or beneficiary concerned will be informed and have the right to object on grounds of commercial confidentiality or conflict of interest.

The coordinator or beneficiary concerned must cooperate diligently and provide — within the deadline requested — any information and data in addition to deliverables and reports already submitted (including information on the use of resources). The granting authority may request beneficiaries to provide such information to it directly. Sensitive information and documents will be treated in accordance with Article 13.

The coordinator or beneficiary concerned may be requested to participate in meetings, including with the outside experts.

For **on-the-spot visits**, the beneficiary concerned must allow access to sites and premises (including to the outside experts) and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the review findings, a **project review report** will be drawn up.

The granting authority will formally notify the project review report to the coordinator or beneficiary concerned, which has 30 days from receiving notification to make observations.

Project reviews (including project review reports) will be in the language of the Agreement, unless otherwise agreed with the granting authority (see Data Sheet, Point 4.2).

25.1.3 Audits

The granting authority may carry out audits on the proper implementation of the action and compliance with the obligations under the Agreement.

Such audits may be started during the implementation of the action and until the time-limit set out in the Data Sheet (see Point 6). They will be formally notified to the beneficiary concerned and will be considered to start on the date of the notification.

The granting authority may use its own audit service, delegate audits to a centralised service or use external audit firms. If it uses an external firm, the beneficiary concerned will be informed and have the right to object on grounds of commercial confidentiality or conflict of interest.

The beneficiary concerned must cooperate diligently and provide — within the deadline requested — any information (including complete accounts, individual salary statements or other personal data) to verify compliance with the Agreement. Sensitive information and documents will be treated in accordance with Article 13.

For **on-the-spot** visits, the beneficiary concerned must allow access to sites and premises (including for the external audit firm) and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the audit findings, a **draft audit report** will be drawn up.

The auditors will formally notify the draft audit report to the beneficiary concerned, which has 30 days from receiving notification to make observations (contradictory audit procedure).

The **final audit report** will take into account observations by the beneficiary concerned and will be formally notified to them.

Audits (including audit reports) will be in the language of the Agreement, unless otherwise agreed with the granting authority (see Data Sheet, Point 4.2).

25.2 European Commission checks, reviews and audits in grants of other granting authorities

Where the granting authority is not the European Commission, the latter has the same rights of checks, reviews and audits as the granting authority.

25.3 Access to records for assessing simplified forms of funding

The beneficiaries must give the European Commission access to their statutory records for the periodic assessment of simplified forms of funding which are used in EU programmes.

25.4 OLAF, EPPO and ECA audits and investigations

The following bodies may also carry out checks, reviews, audits and investigations — during the action or afterwards:

- the European Anti-Fraud Office (OLAF) under Regulations No 883/2013[18] and No 2185/96[19]

- the European Public Prosecutor's Office (EPPO) under Regulation 2017/1939

- the European Court of Auditors (ECA) under Article 287 of the Treaty on the Functioning of the EU (TFEU) and Article 257 of EU Financial Regulation 2018/1046.

If requested by these bodies, the beneficiary concerned must provide full, accurate and complete information in the format requested (including complete accounts, individual salary statements or other personal data, including in electronic format) and allow access to sites and premises for on-the-spot visits or inspections — as provided for under these Regulations.

To this end, the beneficiary concerned must keep all relevant information relating to the action, at least until the time-limit set out in the Data Sheet (Point 6) and, in any case, until any ongoing checks, reviews, audits, investigations, litigation or other pursuits of claims have been concluded.

25.5 Consequences of checks, reviews, audits and investigations — Extension of results of reviews, audits or investigations

25.5.1 Consequences of checks, reviews, audits and investigations in this grant

Findings in checks, reviews, audits or investigations carried out in the context of this grant may lead to rejections (see Article 27), grant reduction (see Article 28) or other measures described in Chapter 5.

Rejections or grant reductions after the final payment will lead to a revised final grant amount (see Article 22).

Findings in checks, reviews, audits or investigations during the action implementation may lead to a request for amendment (see Article 39), to change the description of the action set out in Annex 1.

Checks, reviews, audits or investigations that find systemic or recurrent errors, irregularities, fraud or breach of obligations in any EU grant may also lead to consequences in other EU grants awarded under similar conditions ('extension to other grants').

Moreover, findings arising from an OLAF or EPPO investigation may lead to criminal prosecution under national law.

25.5.2 Extension from other grants

Results of checks, reviews, audits or investigations in other grants may be extended to this grant, if:

(a) the beneficiary concerned is found, in other EU grants awarded under similar conditions, to have committed systemic or recurrent errors, irregularities, fraud or breach of obligations that have a material impact on this grant and

[18] Regulation (EU, Euratom) No 883/2013 of the European Parliament and of the Council of 11 September 2013 concerning investigations conducted by the European Anti-Fraud Office (OLAF) and repealing Regulation (EC) No 1073/1999 of the European Parliament and of the Council and Council Regulation (Euratom) No 1074/1999 (OJ L 248, 18/09/2013, p. 1).

[19] Council Regulation (Euratom, EC) No 2185/96 of 11 November 1996 concerning on-the-spot checks and inspections carried out by the Commission in order to protect the European Communities' financial interests against fraud and other irregularities (OJ L 292, 15/11/1996, p. 2).

(b) those findings are formally notified to the beneficiary concerned — together with the list of grants affected by the findings — within the time-limit for audits set out in the Data Sheet (see Point 6).

The granting authority will formally notify the beneficiary concerned of the intention to extend the findings and the list of grants affected.

If the extension concerns **rejections of unit contributions**: the notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings

(b) the request to submit revised financial statements for all grants affected

(c) the correction rate for extrapolation, established on the basis of the systemic or recurrent errors, to calculate the amounts to be rejected, if the beneficiary concerned:

(i) considers that the submission of revised financial statements is not possible or practicable or

(ii) does not submit revised financial statements.

If the extension concerns **grant reductions**: the notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings and

(b) the **correction rate for extrapolation**, established on the basis of the systemic or recurrent errors and the principle of proportionality.

The beneficiary concerned has **60 days** from receiving notification to submit observations, revised financial statements or to propose a duly substantiated **alternative correction method/rate**.

On the basis of this, the granting authority will analyse the impact and decide on the implementation (i.e. start rejection or grant reduction procedures, either on the basis of the revised financial statements or the announced/alternative method/rate or a mix of those; see Articles 27 and 28).

25.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, unit contributions insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 27), and the grant may be reduced (see Article 28).

Such breaches may also lead to other measures described in Chapter 5.

ARTICLE 26 — IMPACT EVALUATIONS

26.1 Impact evaluation

The granting authority may carry out impact evaluations of the action, measured against the objectives and indicators of the EU programme funding the grant.

Such evaluations may be started during implementation of the action and until the time-limit set out

in the Data Sheet (see Point 6). They will be formally notified to the coordinator or beneficiaries and will be considered to start on the date of the notification.

If needed, the granting authority may be assisted by independent outside experts.

The coordinator or beneficiaries must provide any information relevant to evaluate the impact of the action, including information in electronic format.

26.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the granting authority may apply the measures described in Chapter 5.

CHAPTER 5 CONSEQUENCES OF NON-COMPLIANCE

SECTION 1 REJECTIONS AND GRANT REDUCTION

ARTICLE 27 — REJECTION OF CONTRIBUTIONS

27.1 Conditions

The granting authority will — at beneficiary termination, interim payment, final payment or afterwards — reject any unit contributions which are ineligible (see Article 6), in particular following checks, reviews, audits or investigations (see Article 25).

The rejection may also be based on the extension of findings from other grants to this grant (see Article 25).

Ineligible unit contributions will be rejected.

27.2 Procedure

If the rejection does not lead to a recovery, the granting authority will formally notify the coordinator or beneficiary concerned of the rejection, the amounts and the reasons why. The coordinator or beneficiary concerned may — within 30 days of receiving notification — submit observations if it disagrees with the rejection (payment review procedure).

If the rejection leads to a recovery, the granting authority will follow the contradictory procedure with pre-information letter set out in Article 22.

27.3 Effects

If the granting authority rejects unit contributions, it will deduct them from the contributions declared and then calculate the amount due (and, if needed, make a recovery; see Article 22).

ARTICLE 28 — GRANT REDUCTION

28.1 Conditions

The granting authority may — at beneficiary termination, final payment or afterwards — reduce the grant for a beneficiary, if:

(a) the beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.), or

(b) the beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (see Article 25).

The amount of the reduction will be calculated for each beneficiary concerned and proportionate to the seriousness and the duration of the errors, irregularities or fraud or breach of obligations, by applying an individual reduction rate to their accepted EU contribution.

28.2 Procedure

If the grant reduction does not lead to a recovery, the granting authority will formally notify the coordinator or beneficiary concerned of the reduction, the amount to be reduced and the reasons why. The coordinator or beneficiary concerned may — within 30 days of receiving notification — submit observations if it disagrees with the reduction (payment review procedure).

If the grant reduction leads to a recovery, the granting authority will follow the contradictory procedure with pre-information letter set out in Article 22.

28.3 Effects

If the granting authority reduces the grant, it will deduct the reduction and then calculate the amount due (and, if needed, make a recovery; see Article 22).

SECTION 2 SUSPENSION AND TERMINATION

ARTICLE 29 — PAYMENT DEADLINE SUSPENSION

29.1 Conditions

The granting authority may — at any moment — suspend the payment deadline if a payment cannot be processed because:

(a) the required report (see Article 21) has not been submitted or is not complete or additional information is needed

(b) there are doubts about the amount to be paid (e.g. ongoing audit extension procedure, queries

about eligibility, need for a grant reduction, etc.) and additional checks, reviews, audits or investigations are necessary, or

(c) there are other issues affecting the EU financial interests.

29.2 Procedure

The granting authority will formally notify the coordinator of the suspension and the reasons why.

The suspension will **take effect** the day the notification is sent.

If the conditions for suspending the payment deadline are no longer met, the suspension will be **lifted** — and the remaining time to pay (see Data Sheet, Point 4.2) will resume.

If the suspension exceeds two months, the coordinator may request the granting authority to confirm if the suspension will continue.

If the payment deadline has been suspended due to the non-compliance of the report and the revised report is not submitted (or was submitted but is also rejected), the granting authority may also terminate the grant or the participation of the coordinator (see Article 32).

ARTICLE 30 — PAYMENT SUSPENSION

30.1 Conditions

The granting authority may — at any moment — suspend payments, in whole or in part for one or more beneficiaries, if:

(a) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed or is suspected of having committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.), or

(b) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant.

If payments are suspended for one or more beneficiaries, the granting authority will make partial payment(s) for the part(s) not suspended. If suspension concerns the final payment, the payment (or recovery) of the remaining amount after suspension is lifted will be considered to be the payment that closes the action.

30.2 Procedure

Before suspending payments, the granting authority will send a **pre-information letter** to the beneficiary concerned:

- formally notifying the intention to suspend payments and the reasons why and
- requesting observations within 30 days of receiving notification.

If the granting authority does not receive observations or decides to pursue the procedure despite the observations it has received, it will confirm the suspension (**confirmation letter**). Otherwise, it will formally notify that the procedure is discontinued.

At the end of the suspension procedure, the granting authority will also inform the coordinator.

The suspension will **take effect** the day after the confirmation notification is sent.

If the conditions for resuming payments are met, the suspension will be **lifted**. The granting authority will formally notify the beneficiary concerned (and the coordinator) and set the suspension end date.

During the suspension, no prefinancing will be paid to the beneficiaries concerned. For interim payments, the periodic reports for all reporting periods except the last one (see Article 21) must not contain any financial statements from the beneficiary concerned (or its affiliated entities). The coordinator must include them in the next periodic report after the suspension is lifted or — if suspension is not lifted before the end of the action — in the last periodic report.

ARTICLE 31 — GRANT AGREEMENT SUSPENSION

31.1 Consortium-requested GA suspension

31.1.1 Conditions and procedure

The beneficiaries may request the suspension of the grant or any part of it, if exceptional circumstances — in particular *force majeure* (see Article 35) — make implementation impossible or excessively difficult.

The coordinator must submit a request for **amendment** (see Article 39), with:

- the reasons why
- the date the suspension takes effect; this date may be before the date of the submission of the amendment request and
- the expected date of resumption.

The suspension will **take effect** on the day specified in the amendment.

Once circumstances allow for implementation to resume, the coordinator must immediately request another **amendment** of the Agreement to set the suspension end date, the resumption date (one day after suspension end date), extend the duration and make other changes necessary to adapt the action to the new situation (see Article 39) — unless the grant has been terminated (see Article 32). The suspension will be **lifted** with effect from the suspension end date set out in the amendment. This date may be before the date of the submission of the amendment request.

During the suspension, no prefinancing will be paid. Moreover, no units may be implemented. Ongoing units must be interrupted and no new units may be started. Unit contributions for activities implemented during grant suspension are not eligible (see Article 6.3).

31.2 EU-initiated GA suspension

31.2.1 Conditions

The granting authority may suspend the grant or any part of it, if:

(a) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed or is suspected of having committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.), or

(b) a beneficiary (or a person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant

(c) other:

  (i) linked action issues: not applicable

  (ii) the action has lost its scientific or technological relevance

31.2.2 Procedure

Before suspending the grant, the granting authority will send a **pre-information letter** to the coordinator:

- formally notifying the intention to suspend the grant and the reasons why and
- requesting observations within 30 days of receiving notification.

If the granting authority does not receive observations or decides to pursue the procedure despite the observations it has received, it will confirm the suspension (**confirmation letter**). Otherwise, it will formally notify that the procedure is discontinued.

The suspension will **take effect** the day after the confirmation notification is sent (or on a later date specified in the notification).

Once the conditions for resuming implementation of the action are met, the granting authority will formally notify the coordinator a **lifting of suspension letter**, in which it will set the suspension end date and invite the coordinator to request an amendment of the Agreement to set the resumption date (one day after suspension end date), extend the duration and make other changes necessary to adapt the action to the new situation (see Article 39) — unless the grant has been terminated (see

Article 32). The suspension will be **lifted** with effect from the suspension end date set out in the lifting of suspension letter. This date may be before the date on which the letter is sent.

During the suspension, no prefinancing will be paid. Moreover, no units may be implemented Ongoing units must be interrupted and no new units may be started. Unit contributions for activities implemented during suspension are not eligible (see Article 6.3).

The beneficiaries may not claim damages due to suspension by the granting authority (see Article 33).

Grant suspension does not affect the granting authority's right to terminate the grant or a beneficiary (see Article 32) or reduce the grant (see Article 28).

ARTICLE 32 — GRANT AGREEMENT OR BENEFICIARY TERMINATION

32.1 Consortium-requested GA termination

32.1.1 Conditions and procedure

The beneficiaries may request the termination of the grant.

The coordinator must submit a request for **amendment** (see Article 39), with:

- the reasons why
- the date the consortium ends work on the action ('end of work date') and
- the date the termination takes effect ('termination date'); this date must be after the date of the submission of the amendment request.

The termination will **take effect** on the termination date specified in the amendment.

If no reasons are given or if the granting authority considers the reasons do not justify termination, it may consider the grant terminated improperly.

32.1.2 Effects

The coordinator must — within 60 days from when termination takes effect — submit a **periodic report** (for the open reporting period until termination).

The granting authority will calculate the final grant amount and final payment on the basis of the report submitted and taking into account the unit contributions for activities implemented before the end of work date (see Article 22).

If the granting authority does not receive the report within the deadline, only unit contributions which are included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

Improper termination may lead to a grant reduction (see Article 28).

After termination, the beneficiaries' obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

32.2 Consortium-requested beneficiary termination

32.2.1 Conditions and procedure

The coordinator may request the termination of the participation of one or more beneficiaries, on request of the beneficiary concerned or on behalf of the other beneficiaries.

The coordinator must submit a request for **amendment** (see Article 39), with:

- the reasons why
- the opinion of the beneficiary concerned (or proof that this opinion has been requested in writing)
- the date the beneficiary ends work on the action ('end of work date')
- the date the termination takes effect ('termination date'); this date must be after the date of the submission of the amendment request.

If the termination concerns the coordinator and is done without its agreement, the amendment request must be submitted by another beneficiary (acting on behalf of the consortium).

The termination will **take effect** on the termination date specified in the amendment.

If no information is given or if the granting authority considers that the reasons do not justify termination, it may consider the beneficiary to have been terminated improperly.

32.2.2 Effects

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a **report on the distribution of payments** to the beneficiary concerned

(ii) a **termination report** from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, the financial statement and the explanation on the use of resources

(iii) a second **request for amendment** (see Article 39) with other amendments needed (e.g. reallocation of the tasks and the estimated budget of the terminated beneficiary; addition of a new beneficiary to replace the terminated beneficiary; change of coordinator, etc.).

The granting authority will calculate the amount due to the beneficiary on the basis of the report submitted and taking into account the unit contributions for activities implemented before the end of work date (see Article 22).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 21).

If the granting authority does not receive the termination report within the deadline, only unit contributions which are included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

If the granting authority does not receive the report on the distribution of payments within the deadline, it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

If the second request for amendment is accepted by the granting authority, the Agreement is **amended** to introduce the necessary changes (see Article 39).

If the second request for amendment is rejected by the granting authority (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the grant may be terminated (see Article 32).

Improper termination may lead to a reduction of the grant (see Article 31) or grant termination (see Article 32).

After termination, the concerned beneficiary's obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

32.3 EU-initiated GA or beneficiary termination

32.3.1 Conditions

The granting authority may terminate the grant or the participation of one or more beneficiaries, if:

(a) one or more beneficiaries do not accede to the Agreement (see Article 40)

(b) a change to the action or the legal, financial, technical, organisational or ownership situation of a beneficiary is likely to substantially affect the implementation of the action or calls into question the decision to award the grant (including changes linked to one of the exclusion grounds listed in the declaration of honour)

(c) following termination of one or more beneficiaries, the necessary changes to the Agreement (and their impact on the action) would call into question the decision awarding the grant or breach the principle of equal treatment of applicants

(d) implementation of the action has become impossible or the changes necessary for its continuation would call into question the decision awarding the grant or breach the principle of equal treatment of applicants

(e) a beneficiary (or person with unlimited liability for its debts) is subject to bankruptcy proceedings or similar (including insolvency, winding-up, administration by a liquidator or court, arrangement with creditors, suspension of business activities, etc.)

(f) a beneficiary (or person with unlimited liability for its debts) is in breach of social security or tax obligations

(g) a beneficiary (or person having powers of representation, decision-making or control, or person

essential for the award/implementation of the grant) has been found guilty of grave professional misconduct

(h) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed fraud, corruption, or is involved in a criminal organisation, money laundering, terrorism-related crimes (including terrorism financing), child labour or human trafficking

(i) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) was created under a different jurisdiction with the intent to circumvent fiscal, social or other legal obligations in the country of origin (or created another entity with this purpose)

(j) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under this Agreement or during its award (including improper implementation of the action, non-compliance with the call conditions, submission of false information, failure to provide required information, breach of ethics or security rules (if applicable), etc.)

(k) a beneficiary (or person having powers of representation, decision-making or control, or person essential for the award/implementation of the grant) has committed — in other EU grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (extension of findings from other grants to this grant; see Article 25)

(l) despite a specific request by the granting authority, a beneficiary does not request — through the coordinator — an amendment to the Agreement to end the participation of one of its affiliated entities or associated partners that is in one of the situations under points (d), (f), (e), (g), (h), (i) or (j) and to reallocate its tasks, or

(m) other:

  (i) linked action issues: not applicable

  (ii) the action has lost its scientific or technological relevance

32.3.2 Procedure

Before terminating the grant or participation of one or more beneficiaries, the granting authority will send **a pre-information letter** to the coordinator or beneficiary concerned:

- formally notifying the intention to terminate and the reasons why and
- requesting observations within 30 days of receiving notification.

If the granting authority does not receive observations or decides to pursue the procedure despite the observations it has received, it will confirm the termination and the date it will take effect (**confirmation letter**). Otherwise, it will formally notify that the procedure is discontinued.

For beneficiary terminations, the granting authority will — at the end of the procedure — also inform the coordinator.

The termination will **take effect** the day after the confirmation notification is sent (or on a later date specified in the notification; 'termination date').

32.3.3 Effects

(a) for **GA termination**:

The coordinator must — within 60 days from when termination takes effect — submit a **periodic report** (for the last open reporting period until termination).

The granting authority will calculate the final grant amount and final payment on the basis of the report submitted (see Article 22). Only units implemented until termination will be accepted.

If the grant is terminated for breach of the obligation to submit reports, the coordinator may not submit any report after termination.

If the granting authority does not receive the report within the deadline, only unit contributions which are included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

Termination does not affect the granting authority's right to reduce the grant (see Article 28) or to impose administrative sanctions (see Article 34).

The beneficiaries may not claim damages due to termination by the granting authority (see Article 33).

After termination, the beneficiaries' obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

(b) for **beneficiary termination**:

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a **report on the distribution of payments** to the beneficiary concerned

(ii) a **termination report** from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, the financial statement, and the explanation on the use of resources

(iii) a **request for amendment** (see Article 39) with any amendments needed (e.g. reallocation of the tasks and the estimated budget of the terminated beneficiary; addition of a new beneficiary to replace the terminated beneficiary; change of coordinator, etc.).

The granting authority will calculate the amount due to the beneficiary on the basis of the report submitted (see Article 22). Only units implemented until termination will be accepted.

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 21).

If the granting authority does not receive the termination report within the deadline, only unit contributions included in an approved periodic report will be taken into account (no contributions if no periodic report was ever approved).

If the granting authority does not receive the report on the distribution of payments within the deadline, it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

If the request for amendment is accepted by the granting authority, the Agreement is **amended** to introduce the necessary changes (see Article 39).

If the request for amendment is rejected by the granting authority (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the grant may be terminated (see Article 32).

After termination, the concerned beneficiary's obligations (in particular Articles 13 (confidentiality and security), 16 (IPR), 17 (communication, dissemination and visibility), 21 (reporting), 25 (checks, reviews, audits and investigations), 26 (impact evaluation), 27 (rejections), 28 (grant reduction) and 42 (assignment of claims)) continue to apply.

SECTION 3 OTHER CONSEQUENCES: DAMAGES AND ADMINISTRATIVE SANCTIONS

ARTICLE 33 — DAMAGES

33.1 Liability of the granting authority

The granting authority cannot be held liable for any damage caused to the beneficiaries or to third parties as a consequence of the implementation of the Agreement, including for gross negligence.

The granting authority cannot be held liable for any damage caused by any of the beneficiaries or other participants involved in the action, as a consequence of the implementation of the Agreement.

33.2 Liability of the beneficiaries

The beneficiaries must compensate the granting authority for any damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement, provided that it was caused by gross negligence or wilful act.

The liability does not extend to indirect or consequential losses or similar damage (such as loss of profit, loss of revenue or loss of contracts), provided such damage was not caused by wilful act or by a breach of confidentiality.

ARTICLE 34 — ADMINISTRATIVE SANCTIONS AND OTHER MEASURES

Nothing in this Agreement may be construed as preventing the adoption of administrative sanctions (i.e. exclusion from EU award procedures and/or financial penalties) or other public law measures, in addition or as an alternative to the contractual measures provided under this Agreement (see, for instance, Articles 135 to 145 EU Financial Regulation 2018/1046 and Articles 4 and 7 of Regulation 2988/95[20]).

SECTION 4 FORCE MAJEURE

ARTICLE 35 — FORCE MAJEURE

A party prevented by force majeure from fulfilling its obligations under the Agreement cannot be considered in breach of them.

'Force majeure' means any situation or event that:

- prevents either party from fulfilling their obligations under the Agreement,
- was unforeseeable, exceptional situation and beyond the parties' control,
- was not due to error or negligence on their part (or on the part of other participants involved in the action), and
- proves to be inevitable in spite of exercising all due diligence.

Any situation constituting force majeure must be formally notified to the other party without delay, stating the nature, likely duration and foreseeable effects.

The parties must immediately take all the necessary steps to limit any damage due to force majeure and do their best to resume implementation of the action as soon as possible.

CHAPTER 6 FINAL PROVISIONS

ARTICLE 36 — COMMUNICATION BETWEEN THE PARTIES

36.1 Forms and means of communication — Electronic management

EU grants are managed fully electronically through the EU Funding & Tenders Portal ('Portal').

All communications must be made electronically through the Portal, in accordance with the Portal Terms and Conditions and using the forms and templates provided there (except if explicitly instructed otherwise by the granting authority).

Communications must be made in writing and clearly identify the grant agreement (project number and acronym).

Communications must be made by persons authorised according to the Portal Terms and Conditions. For naming the authorised persons, each beneficiary must have designated — before the signature of

[20] Council Regulation (EC, Euratom) No 2988/95 of 18 December 1995 on the protection of the European Communities financial interests (OJ L 312, 23.12.1995, p. 1).

this Agreement — a 'legal entity appointed representative (LEAR)'. The role and tasks of the LEAR are stipulated in their appointment letter (see Portal Terms and Conditions).

If the electronic exchange system is temporarily unavailable, instructions will be given on the Portal.

36.2 Date of communication

The sending date for communications made through the Portal will be the date and time of sending, as indicated by the time logs.

The receiving date for communications made through the Portal will be the date and time the communication is accessed, as indicated by the time logs. Formal notifications that have not been accessed within 10 days after sending, will be considered to have been accessed (see Portal Terms and Conditions).

If a communication is exceptionally made on paper (by e-mail or postal service), general principles apply (i.e. date of sending/receipt). Formal notifications by registered post with proof of delivery will be considered to have been received either on the delivery date registered by the postal service or the deadline for collection at the post office.

If the electronic exchange system is temporarily unavailable, the sending party cannot be considered in breach of its obligation to send a communication within a specified deadline.

36.3 Addresses for communication

The Portal can be accessed via the Europa website.

The address for paper communications to the granting authority (if exceptionally allowed) is the official mailing address indicated on its website.

For beneficiaries, it is the legal address specified in the Portal Participant Register.

ARTICLE 37 — INTERPRETATION OF THE AGREEMENT

The provisions in the Data Sheet take precedence over the rest of the Terms and Conditions of the Agreement.

Annex 5 takes precedence over the Terms and Conditions; the Terms and Conditions take precedence over the Annexes other than Annex 5.

Annex 2 takes precedence over Annex 1.

ARTICLE 38 — CALCULATION OF PERIODS AND DEADLINES

In accordance with Regulation No 1182/71[21], periods expressed in days, months or years are calculated from the moment the triggering event occurs.

The day during which that event occurs is not considered as falling within the period.

[21] Regulation (EEC, Euratom) No 1182/71 of the Council of 3 June 1971 determining the rules applicable to periods, dates and time-limits (OJ L 124, 8/6/1971, p. 1).

'Days' means calendar days, not working days.

ARTICLE 39 — AMENDMENTS

39.1 Conditions

The Agreement may be amended, unless the amendment entails changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

Amendments may be requested by any of the parties.

39.2 Procedure

The party requesting an amendment must submit a request for amendment signed directly in the Portal Amendment tool.

The coordinator submits and receives requests for amendment on behalf of the beneficiaries (see Annex 3). If a change of coordinator is requested without its agreement, the submission must be done by another beneficiary (acting on behalf of the other beneficiaries).

The request for amendment must include:

- the reasons why
- the appropriate supporting documents and
- for a change of coordinator without its agreement: the opinion of the coordinator (or proof that this opinion has been requested in writing).

The granting authority may request additional information.

If the party receiving the request agrees, it must sign the amendment in the tool within 45 days of receiving notification (or any additional information the granting authority has requested). If it does not agree, it must formally notify its disagreement within the same deadline. The deadline may be extended, if necessary for the assessment of the request. If no notification is received within the deadline, the request is considered to have been rejected.

An amendment **enters into force** on the day of the signature of the receiving party.

An amendment **takes effect** on the date of entry into force or other date specified in the amendment.

ARTICLE 40 — ACCESSION AND ADDITION OF NEW BENEFICIARIES

40.1 Accession of the beneficiaries mentioned in the Preamble

The beneficiaries which are not coordinator must accede to the grant by signing the accession form (see Annex 3) directly in the Portal Grant Preparation tool, within 30 days after the entry into force of the Agreement (see Article 44).

They will assume the rights and obligations under the Agreement with effect from the date of its entry into force (see Article 44).

If a beneficiary does not accede to the grant within the above deadline, the coordinator must — within 30 days — request an amendment (see Article 39) to terminate the beneficiary and make any changes necessary to ensure proper implementation of the action. This does not affect the granting authority's right to terminate the grant (see Article 32).

40.2 Addition of new beneficiaries

In justified cases, the beneficiaries may request the addition of a new beneficiary.

For this purpose, the coordinator must submit a request for amendment in accordance with Article 39. It must include an accession form (see Annex 3) signed by the new beneficiary directly in the Portal Amendment tool.

New beneficiaries will assume the rights and obligations under the Agreement with effect from the date of their accession specified in the accession form (see Annex 3).

Additions are also possible in mono-beneficiary grants.

ARTICLE 41 — TRANSFER OF THE AGREEMENT

In justified cases, the beneficiary of a mono-beneficiary grant may request the transfer of the grant to a new beneficiary, provided that this would not call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiary must submit a request for **amendment** (see Article 39), with

- the reasons why
- the accession form (see Annex 3) signed by the new beneficiary directly in the Portal Amendment tool and
- additional supporting documents (if required by the granting authority).

The new beneficiary will assume the rights and obligations under the Agreement with effect from the date of accession specified in the accession form (see Annex 3).

ARTICLE 42 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE GRANTING AUTHORITY

The beneficiaries may not assign any of their claims for payment against the granting authority to any third party, except if expressly approved in writing by the granting authority on the basis of a reasoned, written request by the coordinator (on behalf of the beneficiary concerned).

If the granting authority has not accepted the assignment or if the terms of it are not observed, the assignment will have no effect on it.

In no circumstances will an assignment release the beneficiaries from their obligations towards the granting authority.

ARTICLE 43 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES

43.1 Applicable law

The Agreement is governed by the applicable EU law, supplemented if necessary by the law of Belgium.

Special rules may apply for beneficiaries which are international organisations (if any; see Data Sheet, Point 5).

43.2 Dispute settlement

If a dispute concerns the interpretation, application or validity of the Agreement, the parties must bring action before the EU General Court — or, on appeal, the EU Court of Justice — under Article 272 of the Treaty on the Functioning of the EU (TFEU).

For non-EU beneficiaries (if any), such disputes must be brought before the courts of Brussels, Belgium — unless an international agreement provides for the enforceability of EU court judgements.

For beneficiaries with arbitration as special dispute settlement forum (if any; see Data Sheet, Point 5), the dispute will — in the absence of an amicable settlement — be settled in accordance with the Rules for Arbitration published on the Portal.

If a dispute concerns administrative sanctions, offsetting or an enforceable decision under Article 299 TFEU (see Articles 22 and 34), the beneficiaries must bring action before the General Court — or, on appeal, the Court of Justice — under Article 263 TFEU.

For grants where the granting authority is an EU executive agency (see Preamble), actions against offsetting and enforceable decisions must be brought against the European Commission (not against the granting authority; see also Article 22).

ARTICLE 44 — ENTRY INTO FORCE

The Agreement will enter into force on the day of signature by the granting authority or the coordinator, depending on which is later.

SIGNATURES

For the coordinator

Kęstutis BALTAKYS with ECAS id nbaltake signed in the Participant Portal on 04/08/2024 at 23:54:21 (transaction id SigId-51073-GzsHiGerXokGwJxDKPrvF4qNV2GvptozKid4BKfZsR4IcIXjYq7EH08rBP8xnzr6vOrDjFkjH3seLuGfzbNoZ8q-yntOf97TTHqAX5yfJ7HQNG-2CnWAxCfLOQExzK6ukTx3Pp1fzmFJdG6Ixl43dEexEmvjGdH1gGlA6aReInLV8zeyEPeS7zxN7NkavSau2RsV1u). Timestamp by third party at 2024.08.04 23:54:28 CEST

For the granting authority

Signed by Monika HOLIK with ECAS id holikma as an authorised representative on 06-08-2024 13:36:57 (transaction id SigId-68337-G57IrCB7RzpSckzNE2f1XYSmcAFStJlotuDBttfuNHnWkfJeeIp6UqzgUYlf7fT0lDXCHnBmRDMzzmezsx8xB5zi-yntOf97TTHqAX5yfJ7HQNG-Pqt0g8ZyVKIowms4OCtzxCLkSMhCzbGmXZ4SkvtNdkSsJiqk7rCqkCjlhS7bwHBzhLpwCGe5JvXcWfBy4dRLud0)
2024.08.06 13:37:00 CEST

ANNEX 1

Horizon Europe (HORIZON)

Description of the action (DoA)

Part A

Part B

DESCRIPTION OF THE ACTION (PART A)

COVER PAGE

Part A of the Description of the Action (DoA) must be completed directly on the Portal Grant Preparation screens.

PROJECT *Grant Preparation (General Information screen) — Enter the info.*	
Project number:	101182521
Project name:	Multifunctional fibre-reinforced plastic composites with MXene layers
Project acronym:	MIRACLES
Call:	HORIZON-MSCA-2023-SE-01
Topic:	HORIZON-MSCA-2023-SE-01-01
Type of action:	HORIZON-TMA-MSCA-SE
Service:	REA/A/03
Project starting date:	fixed date: 1 January 2025
Project duration:	48 months

TABLE OF CONTENTS

PROJECT SUMMARY

Project summary

Grant Preparation (General Information screen) — Provide an overall description of your project (including context and overall objectives, planned activities and main achievements, and expected results and impacts (on target groups, change procedures, capacities, innovation etc)). This summary should give readers a clear idea of what your project is about.

Use the project summary from your proposal.

Fibre-reinforced plastic composites (FRPC) are widely used in advanced fields such as aviation, shipbuilding, wind energy, etc. FRPC structures, during exploitation, lose loadbearing capacity because of local damage, icing, water absorption and other factors. The specific objective of the MIRACLES fundamental research is FRPC with the tailored additional functionality of damage monitoring, de-icing, self-sensing, and moisture barrier protection. These functions are implemented using thin MXene-dopped coatings and (or) interlayers. Novel two-dimensional MXene nanoparticles uniquely combine high electrical conductivity and mechanical properties realised under the high alignment of the particles in thin coatings and (or) interlayers.

The workflow in the project combines theoretical modelling and experimental research with nano-engineered technologies for validation, upscaling, and demonstrating. Novel eco-friendly methods of MXene delamination and exfoliation will be explored together with the possibilities of reagent recycling. An automated spray and print methods with precisely controlled nanoparticle quality will be explored. Layer sensitivity will be improved with the new technology using different nanoparticle and polymer configurations. New surface temperature annealing, antioxidants, and protective polymer coatings will be explored to increase stability further.

The objectives and contributions to the impact will be achieved through 117 secondments for 205 person-months, homework, and other networking actions. The interdisciplinary and intersectoral consortium of six academic and four industrial partners from six EU countries has complementary expertise in Materials Engineering, Mechanical Engineering, and Chemical Sciences. By starting from TRL3, the project plans to grow forward to TRL6.

The greatest impact of this innovation will be achieved by making FRPC structures safer, cleaner and cheaper.

LIST OF PARTICIPANTS

PARTICIPANTS

Grant Preparation (Beneficiaries screen) — Enter the info.

Number	Role	Short name	Legal name	Country	PIC
1	COO	KTU	KAUNO TECHNOLOGIJOS UNIVERSITETAS	LT	999844961
2	BEN	LU	LATVIJAS UNIVERSITATE	LV	999871830
3	BEN	PISAS	USTAV POLYMEROV SLOVENSKEJ AKADEMIEVIED VEREJNA VYSKUMNA INSTITUCIA	SK	998528574
4	BEN	VSCHT	VYSOKA SKOLA CHEMICKO-TECHNOLOGICKA V PRAZE	CZ	999867853
5	BEN	CNR	CONSIGLIO NAZIONALE DELLE RICERCHE	IT	999979500
6	BEN	LTU	LULEA TEKNISKA UNIVERSITET	SE	999876874
7	BEN	SYNPO	SYNPO AKCIOVA SPOLECNOST	CZ	988900063
8	BEN	STIDO	UAB STIDO	LT	879736069
9	BEN	COMEC	COMEC - COSTRUZIONI MECCANICHE INNOVATIVE SRL	IT	950066695
10	BEN	SA	UAB SPORTINE AVIACIJA IR KO	LT	918723182

LIST OF WORK PACKAGES

Work packages

Grant Preparation (Work Packages screen) — Enter the info.

Work Package No	Work Package name	Lead Beneficiary	Effort (Person-Months)	Start Month	End Month	Deliverables
WP1	New materials development	3 - PISAS	65.00	1	36	D1.1 – Report on preparation of MXene by new synthesis and exfoliation method D1.2 – Report on binder-free MXene and MXene-polymer composite layers characterisation
WP2	Theoretical modelling	2 - LU	36.00	7	36	D2.1 – Report on macro-structural modelling of barrier, damage identification, and heating properties
WP3	Testing for validation	6 - LTU	46.00	16	45	D3.1 – Report on the validation of multifunctional properties of MXene-based layers in FRPC
WP4	Up-scaling and demonstrating	8 - STIDO	58.00	22	48	D4.1 – Report on the verified technology of MXene production and up-scaling findings D4.2 – Report on three physical demonstrators of the multifunctional properties of PRPC with MXene-based layers
WP5	Knowledge transfer	5 - CNR	0.00	1	48	
WP6	Communication, exploitation, and dissemination	1 - KTU	0.00	1	48	D6.1 – Dissemination plan
WP7	Management	1 - KTU	0.00	1	48	D7.1 – Data Management Plan (DMP) D7.2 – Progress Report D7.3 – Mid-term meeting

Associated with document Ref. Ares(2024)5613046 - 02/08/2024

Work package WP1 – New materials development

Work Package Number	WP1	Lead Beneficiary	3 - PISAS
Work Package Name	New materials development		
Start Month	1	End Month	36

Objectives
Preparation and characterisation of homogeneous, stable, and thin binder-free MXene and MXene-polymer composite layers.

Description
Description of Work and role of partners: T1.1 State-of-the-art mapping of MXene formulations [Task leader: PISAS; partners: CNR, KTU]. The interdisciplinary task (IDT), based on the necessity of knowledge in polymer chemistry (PISAS), materials for sensors (CNR), and materials and mechanical engineering (KTU). The state-of-the-art mapping of alternative solutions on MXene-based formulations preparation, the ability to sense the damage, Joule heating and barrier properties. Applicable requirements for innovative MXene formulations will be derived: (a) compatibility of materials and processes (b) compliance with appearance requirements; (c) durability and reliability under in-service conditions environmental (temperature, humidity) and mechanical (static and fatigued cycling) loadings. T1.2 MXene synthesis and exfoliation [Task leader: VSCHT; partners: PISAS, KTU, LU]. The IDT, based on the necessity of knowledge in inorganic chemistry (VSCHT), polymer chemistry (PISAS), and materials and mechanical engineering (KTU, LU). VSCHT: transition from standard synthesis and exfoliation procedures to non-aggressive ones, based on direct reaction with a controlled amount of free halide in organic solvents, which can be easily recycled by distillation; development of waste-free methods based on standard MXene exfoliation procedures. PISAS: Research into the compatibility of synthesized MXene nanoparticles with polymeric matrices and the optimization of MXene terminal functional groups according to potential chemical bonds in polymeric matrices. KTU, LU: The investigation of the electrical and mechanical behaviour of synthesized MXene by producing specific samples tailored for these studies. T1.3 Development of binder-free MXene formulation for layers [Task leader: VSCHT; partners: CNR, KTU, LTU]. The IDT, based on the necessity of knowledge in inorganic chemistry (VSCHT), 2D materials, thin films (CNR), and materials engineering (KTU, LTU). VSCHT: preparation of concentrated inorganic water-born MXene suspension. CNR: the technology of ultra-thin stable homogenous MXene nanolayer deposition on substrates by spray, jet print, and doctor-blade methods; the use of various surfactants to improve stability and ensure homogeneous layer. KTU, LTU: thermal imaging under DC to check the layer integrity and uniformity and reveal high-resistive areas that require additional material; adhesive properties between the layer and substrate, wettability, and similar characteristics to evaluate the formulation's suitability. T1.4 Development of MXene-polymer composite for layers [Task leader: PISAS; partners: VSCHT, KTU, LTU; LU]. The IDT, based on the necessity of knowledge in inorganic chemistry (VSCHT), polymer chemistry (PISAS), and materials engineering (KTU, LTU, LU). VSCHT: preparation of concentrated inorganic water- and solvent-born MXene suspension. PISAS: new formulations of MXene-polymer composites will be designed and prepared; water- and solvent-borne systems of polymeric matrices will be investigated; technology of thin stable homogenous MXene-polymer layers will be developed. KTU, LTU, LU: investigation and assessment of adhesive properties between the MXene-polymer layer and FRPC substrate, wettability, and basic mechanical characteristics will be carried out to evaluate the nanocomposites's suitability for use in subsequent tasks. T1.5 Characterisation of new materials [Task leader: CNR; partners: KTU, LTU, PISAS, LU]. The IDT, based on the necessity of knowledge in 2D materials, thin films (CNR), polymer chemistry (PISAS), and materials and mechanical engineering (KTU, LTU, LU). CNR, PISAS: samples for MXene-based binder-free formulation characterisation preparation and investigation under XPS, FTIR, Raman spectroscopy, and microscopy methods in combination with elemental analysis, including SEM/EDS and TEM/EDS/EELS. KTU, LTU, LU: thermal stability explored by DSC/TG-MS methods; the hydrophilicity and surface energy of prepared samples studied by contact angle measurements; nanomechanical properties and surface morphology of prepared heterostructured samples will be studied by nanoindentation. The electrical properties of prepared films and layers will be measured using the standard four-probe method; mechanical tests will be performed (hardness, elastic and complex modulus, interlaminar fracture toughness, pull-out measurements).

Associated with document Ref. Ares(2024)5613046 - 02/08/2024

Work package WP2 – Theoretical modelling

Work Package Number	WP2	Lead Beneficiary	2 - LU
Work Package Name	Theoretical modelling		
Start Month	7	End Month	36

Objectives
Analytical and numerical modelling for the predictive analysis and optimisation of smart properties of MXene-based layers. Experimental characterisation of the system MXene based layer-FRPC substrate and its components to obtain the data necessary for modelling.

Description
T2.1 Joule heating modelling [Task leader: LU; partners: KTU, CNR]. The IDT, based on the necessity of knowledge in materials and mechanical engineering (KTU, LU) and 2D materials, thin films (CNR). LU, KTU: One-dimensional (1D) analytical modelling of the heating process for a preliminary layer design for de-icing applications and detailed 2D/3D FEM for predicting the local temperature distribution. Analytical modelling includes two steps. The first one is the Joule heating calculation based on current density and modelled conductivity on the layer. The second step is heat transfer modelling based on classical Fourier equations applied to define the composite properties by inverse calculation. These data will later be applied to FEM modelling software for the calculation of the local heat transfer. CNR: preparation of materials samples for input data for optimal real-world correlation; structural data collection analysing SEM and TEM results. T2.2 Damage identification modelling [Task leader: KTU; partners: LU, CNR]. The IDT, based on the necessity of knowledge in materials and mechanical engineering (KTU, LU) and 2D materials, materials for sensors (CNR). KTU, LU: Electromechanical modelling with damage identification based on the localised EPG will be investigated using the FEMU. Numerical analysis will be carried out to define the micromechanical fracture behaviour of MXene and LbL-based nanolayers. The FEMU procedure will be implemented using a Surface Response Optimisation technique, incorporating Central Composite Design and Sparse Grid Initialization. Optimization methods will be employed. CNR: preparation of materials samples for optimal real-world correlation; analysing SEM, TEM results. T2.3 Barrier properties modelling [Task leader: LU; partners: KTU, CNR]. The IDT, based on the necessity of knowledge in materials and mechanical engineering (KTU, LU) and 2D materials, thin films (CNR). LU, KTU: the structural modelling approach will be based on micromechanics of disperse-filled polymers and macro-structural modelling considering the 1D water diffusion process described by Fick law through a layer and FRPC substrate system. As for Task 2.1, analytical modelling based on the classical second Fick's water transfer equation will be applied to define the composite properties by inverse calculation. These data will later be applied to FEM modelling software like ANSYS for calculation of the local water transfer in the system of the layer and substrate (FRPC). CNR: preparation of materials samples for theoretical model input data for optimal real-world correlation; structural data collection through the analysing SEM and TEM results.

Work package WP3 – Testing for validation

Work Package Number	WP3	Lead Beneficiary	6 - LTU
Work Package Name	Testing for validation		
Start Month	16	End Month	45

Objectives
Validation of multifunctional properties of binder-free MXene and MXene-polymer composite layers by experimental testing of developed FRPC.

Description
T3.1 De-icing tests [Task leader: KTU; partners: PISAS, SYNPO]. The IDT, based on the necessity of knowledge in materials and mechanical engineering (KTU) and polymer chemistry (PISAS). PISAS: preparing samples by chemical

treatment of the polymeric FRPC or prepreg surface. KTU: testing and analysis of thermal behaviour of new FRPC with MXene-based layers, based on the Joule heating effect for the de-icing applications in FRPC. The MXene-based layers' suitability for de-icing will be proved and validated experimentally. SYNPO: refinement of industrial needs based on market requirements and ensuring achievement by contributing to the testing at KTU.
T3.2. Local curing tests [Task leader: LTU; partners: KTU, CNR, STIDO]. The IDT, based on the necessity of knowledge in materials and mechanical engineering (LTU, KTU, STIDO) and 2D materials (CNR). CNR: 2D MXene deposition on the substrates using the LbL technique, assessing the number of nanolayers required to ensure the desired Joule heating properties of the layer. LTU, KTU, STIDO: HRT to determine the temperature profiles during and after the curing process on the surface of the specimen; DSC, TGA and DMTA to evaluate degree of cure and different properties of the cured material. Nano-indentation to precisely assess the mechanical properties, in areas where potential defects might be present.
T3.3 Strain sensing tests [Task leader: LTU; partners: KTU, COMEC, LU]. The development of geometry of the printed strain gauge sensor and characterisation of the printing process to obtain exactly the geometries required by design. Printing tests to ensure that formulation viscosity is in line with the machine and systems characteristics. Layer spraying technology will be worked out. The effectiveness of MXene layers in sensing strain and damage will be validated through tests on FRPC samples with integrated layers under various loadings while observing the electromechanical response of the MXene-based layers. Moreover, the suitability of MXene-based layers will be validated for sensing by testing coupons with artificial scratches and notches that will mimic realistic damage.
T3.4 Investigation of barrier properties [Task leader: LU; partner: SA]. The investigation of the moisture sorption process in the coating under different relative humidity on samples of the new MXene-based materials developed for coatings in WP1 and the sorption experiments on the coating-FRPC substrate system. The process uses models developed in WP2 Task 2.3. The model parameters defined and transferred in T2.3 provide experimental testing feedback on modelling and its validation. 1D water diffusion process is implemented in a humid environment, choosing specific sample geometry prepared in WP1.

Work package WP4 – Up-scaling and demonstrating

Work Package Number	WP4	**Lead Beneficiary**	8 - STIDO
Work Package Name	Up-scaling and demonstrating		
Start Month	22	**End Month**	48

Objectives
The up-scaling of novel non-aggressive MXene production and exfoliation methods and demonstration of the multifunctional properties of FRPC with MXene-based layers.

Description
T4.1 Optimised production of MXenes with controlled surface functionalisation [Task leader: SYNPO; partners: VSCHT, PISAS, CNR]. Molten salt experiments using various ratio of transition metal halides and eutectic mixtures of alkali metal and alkaline earth metals halogens to reduce reaction temperature and amount of used transition metal halide; selective etching of aluminium by free halogens using extraction-based system. T4.2 Optimised production of MXene-polymer composite materials [Task leader: SYNPO; partners: CNR, STIDO; COMEC]. The IDT, based on the necessity of knowledge in industrial chemistry (SYNPO, CNR) and production technology (STIDO, COMEC). SYNPO, CNR: up-scaling of the dispersion procedure and on the optimisation of MXene introduction into the polymer matrix; preparation of MXene-based formulations' concentrates and their introduction into the polymer matrix; optimisation of the process of applying composite materials on selected substrates, with regard to the required final properties. STIDO, COMEC: sensor printing tests and physical-electrical characterisation of the sensor. T4.3 Demonstrator for Joule heating applications [Task leader: STIDO; partners: KTU, SYNPO]. The IDT, based on the necessity of knowledge in production technology (STIDO, KTU) and industrial chemistry (SYNPO). STIDO, KTU: FRPC demonstrator having a shape of a plate with ultra-fast heating capability using MXene-based layer and capacitors will be designed and manufactured; for showing de-icing possibilities, the ice accumulation tracking algorithm based on the layer's temperature coefficient of resistance and local heating ability, will be developed. SYNPO: expertise will be utilized to demonstrate the local curing function; SYNPO will be responsible for determining the temperatures required for curing and will contribute to the balancing of the demonstrator by setting the specific temperature needed for resin curing.

T4.4 Demonstrator for sensing applications [Task leader: COMEC; partners: KTU, CNR]. The FRPC demonstrator having a shape of a plate with printed and/or sprayed MXene-based layer having the ability to sense the structure's strains and surface cracking due to cyclic loading and local impact damages will be designed and manufactured. The data from the electrically conductive layer will be processed in MATLAB software, and the damaged area will be visually presented to the end user/owner.
T4.5 Demonstrator of improved barrier properties [Task leader: SA; partners: LU]. The design and development of a model structure demonstrate improved barrier properties of the layer. A moisture sorption process is implemented on the substrates with nano-modified and reference layers. Due to improvement in the barrier properties, the duration of the moisture protection is expected to be several times longer.

Work package WP5 – Knowledge transfer

Work Package Number	WP5	**Lead Beneficiary**	5 - CNR
Work Package Name	Knowledge transfer		
Start Month	1	**End Month**	48

Objectives
(1) training of scientific skills with emphasis on the multidisciplinary approach to solve research issues; (2) training of general skills such as project management, writing and presentation skills, general issues regarding work ethics, gender issues, cultural differences in the work environment; (3) technology champions and entrepreneurship training, focused on demonstrator development, intellectual properties protection, grant writing skills, implementation of research into innovative products.

Description
T5.1 Professional development via exchange of staff during secondments [Task leader: KTU; partners: all]. Professional training, sharing of knowledge and experience among project participants will be conducted by: research-based training, industrial-based training, and seminars. This will include: share knowledge necessary to perform experimental tasks, training on the techniques, data interpretation. T5.2 Training schools [Task leader: LTU; partners: all]. Two training schools open to outside participants, 3 days each, will be given by academic partners in M12 and M36. The schools will be based on scientific courses given in all the topics developed in the project. T5.3 MIRACLES Workshops [Task leader: CNR; partners: all]. Two scientific workshops will be organised. The first one will be on open science practices and will be on-line event in M6. The second scientific workshop will be organised during an in-person closing meeting of the project partners (M48). Doctoral candidates and postdocs will present the results they achieved during the MIRACLES project. T5.4 Entrepreneurship experience for young researchers [Task leader: STIDO; partners: all]. Industry partners will organize a small event to share experiences and motivate young researchers. The event will be organised during an in-person meeting of the project partners in M24.

Work package WP6 – Communication, exploitation, and dissemination

Work Package Number	WP6	**Lead Beneficiary**	1 - KTU
Work Package Name	Communication, exploitation, and dissemination		
Start Month	1	**End Month**	48

Objectives
(1) to create awareness of the MIRACLES project to a wide audience; (2) to enhance the visibility of MIRACLES activities at local, national and international level; (3) to attract talented young researchers to be involved in MIRACLES activities; (4) to attract the interest of potential industry partners; (5) to draw the attention of authorities, public and

private funding sources to the need for benefits of research of composite science; (6) to search for academic, educational, industrial implementers to exploit project results; (7) to generate market demand; (8) to receive a feedback.

Description
T6.1 Impact maximisation team [Task leader: KTU; partners: all]. To manage the dissemination, exploitation, and communication activities, an impact maximisation team will be formed and the communication manager will be dedicated. T6.2 Dissemination, exploitation, communication plans (DECP) [Task leader: KTU; partners: all]. DECP will be worked out, discussed and approved during the first meeting of consortium. These plans will describe the impact maximisation goals, target groups, actions of the consortium. T6.3 Visual identity of the project [Task leader: LU; partners: all]. The design of the project logo and style will be created to increase the project's recognition in society. Templates for presentations and posters will be used to present research results at the conferences. Designed visual identity will be used for website, social media, posters, flyers and other impact maximisation means to increase project visibility. T6.4 Dissemination and communication [Task leader: LU; partners: all]. Scientific results of the project will be published in journals with a high impact factor, presented on several world-known conferences like ECCM, ICCM, etc. To make research accessible for researchers, industry and citizens, Green and Golden Access models will be used for publications. Posters, booklets, and flayers will be prepared to advertise the MIRACLES project. For communication with the "non-scientific public", a website and articles in local news portals with adapted information will be prepared. The social and research networks like ResearchGate, LinkedIn, Facebook will be used as well. T6.5 Exploitation strategy [Task leader: SYNPO; partners: all]. The exploitation of results and continuous commitment of partners to the objectives of MIRACLES will be carried out according to plan. The work will continue on the "MXene for FRPC" topic, and new proposals will be prepared for international calls. Industry partners will critically assess the relevance of obtained results and risks associated with innovative technologies/products.

Work package WP7 – Management

Work Package Number	WP7	Lead Beneficiary	1 - KTU
Work Package Name	Management		
Start Month	1	End Month	48

Objectives
(1) establishment of project management structure and coordination of activities according to the work plan; (2) ensure an effective establishment of networking between partners for exchange of staff; (3) prepare and maintain a risk management and data management plans; (4) guarantee transfer of information between Research Executive Agency and partners; (5) coordinate IPR and other innovation-related activities.

Description
T7.1 Daily coordination [Task leader: KTU; partners: all]. The coordinator will certify that all the requirements set by the REA concerning reporting and information are met. Prof. Dr. Daiva Zeleniakiene be responsible for overall management. All the issues arising during project execution will be thoroughly discussed with participants. The communication between partners will be based on: (1) day-to-day e-mail contact between the coordinator and partners; (2) bimonthly online consortium meetings; (3) yearly presential meetings of the consortium; (4) scientific progress and final reports and scientific meetings organized by the coordinator and appointed partners. T7.2 Information sharing platform [Task leader: KTU; partners: all]. For the information sharing between all consortium members, a shared folder website will be prepared available to all the partners. The coordinator will be responsible for the all-necessary documents will be uploaded, protected, and available for the use of consortium members, the timely update of information from WP leaders will be monitored also. To ensure continued access to the information cloud storage will be used. T7.3 Data and research outputs management [Task leader: KTU; partners: all]. DMP will be prepared in line with the FAIR principles. The coordinator will be responsible for the implementation of this plan, ensuring the involvement of all project partners. T7.4 Risk management [Task leader: KTU; partners: all]. The coordinator will elaborate a plan, listing possible risks

associated with MIRACLES. Critical analysis of those risks will be done, and strategies to circumvent obstacles and keep the project on track will be presented.

STAFF EFFORT

Staff effort per participant

Grant Preparation (Work packages - Effort screen) — Enter the info.

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	Total Person-Months
1 - KTU	14.00	12.00	11.00	5.00				42.00
2 - LU	13.00	20.00	4.00	3.00				40.00
3 - PISAS	16.00		4.00	5.00				25.00
4 - VSCHT	5.00			1.00				6.00
5 - CNR	11.00	4.00	2.00	8.00				25.00
6 - LTU	6.00		12.00					18.00
7 - SYNPO			1.00	8.00				9.00
8 - STIDO			6.00	14.00				20.00
9 - COMEC			2.00	8.00				10.00
10 - SA			4.00	6.00				10.00
Total Person-Months	65.00	36.00	46.00	58.00	0.00	0.00	0.00	205.00

LIST OF DELIVERABLES

Deliverables

Grant Preparation (Deliverables screen) — Enter the info.

The labels used mean:

Public — fully open (⚠ automatically posted online)
Sensitive — limited under the conditions of the Grant Agreement
EU classified —RESTREINT-UE/EU-RESTRICTED, CONFIDENTIEL-UE/EU-CONFIDENTIAL, SECRET-UE/EU-SECRET under Decision 2015/444

Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
D1.1	Report on preparation of MXene by new synthesis and exfoliation method	WP1	4 - VSCHT	R — Document, report	SEN - Sensitive	24
D1.2	Report on binder-free MXene and MXene-polymer composite layers characterisation	WP1	3 - PISAS	R — Document, report	SEN - Sensitive	36
D2.1	Report on macro-structural modelling of barrier, damage identification, and heating properties	WP2	2 - LU	R — Document, report	SEN - Sensitive	36
D3.1	Report on the validation of multifunctional properties of MXene-based layers in FRPC	WP3	6 - LTU	R — Document, report	SEN - Sensitive	45
D4.1	Report on the verified technology of MXene production and up-scaling findings	WP4	7 - SYNPO	R — Document, report	SEN - Sensitive	42
D4.2	Report on three physical demonstrators of the multifunctional properties of PRPC with MXene-based layers	WP4	8 - STIDO	R — Document, report	SEN - Sensitive	48
D6.1	Dissemination plan	WP6	1 - KTU	R — Document, report	SEN - Sensitive	6
D7.1	Data Management Plan (DMP)	WP7	1 - KTU	DMP — Data Management Plan	PU - Public	6
D7.2	Progress Report	WP7	1 - KTU	R — Document, report	SEN - Sensitive	13

Deliverables

Grant Preparation (Deliverables screen) — Enter the info.

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Public — fully open (automatically posted online)
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EU classified —RESTREINT-UE/EU-RESTRICTED, CONFIDENTIEL-UE/EU-CONFIDENTIAL, SECRET-UE/EU-SECRET under Decision 2015/444

Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
D7.3	Mid-term meeting	WP7	1 - KTU	R — Document, report	SEN - Sensitive	18

Associated with document Ref. Ares(2024)5613046 - 02/08/2024

Deliverable D1.1 – Report on preparation of MXene by new synthesis and exfoliation method

Deliverable Number	D1.1	Lead Beneficiary	4 - VSCHT
Deliverable Name	Report on preparation of MXene by new synthesis and exfoliation method		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	24	Work Package No	WP1

Description
New methods of MXene synthesis and functionalization based on sustainable technologies comprising recycling of used harmful and expensive chemicals will be presented.

Deliverable D1.2 – Report on binder-free MXene and MXene-polymer composite layers characterisation

Deliverable Number	D1.2	Lead Beneficiary	3 - PISAS
Deliverable Name	Report on binder-free MXene and MXene-polymer composite layers characterisation		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	36	Work Package No	WP1

Description
Homogeneous and stable binder-free MXene and MXene-polymer composite layers with excellent adhesion to FRPC substrate will be developed.

Deliverable D2.1 – Report on macro-structural modelling of barrier, damage identification, and heating properties

Deliverable Number	D2.1	Lead Beneficiary	2 - LU
Deliverable Name	Report on macro-structural modelling of barrier, damage identification, and heating properties		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	36	Work Package No	WP2

Description
Analytical and numerical models for the calculation of properties of MXene-based layers will be developed; experimental characterisation of the system MXene based layer-FRPC substrate and its components will be performed, and the models will be prepared for validation.

Deliverable D3.1 – Report on the validation of multifunctional properties of MXene-based layers in FRPC

Deliverable Number	D3.1	Lead Beneficiary	6 - LTU
Deliverable Name	Report on the validation of multifunctional properties of MXene-based layers in FRPC		
Type	R — Document, report	Dissemination Level	SEN - Sensitive

Due Date (month)	45	Work Package No	WP3

Description
The final formulation for MXene-based layers with heating, strain and damage sensing and barrier capabilities.

Deliverable D4.1 – Report on the verified technology of MXene production and up-scaling findings

Deliverable Number	D4.1	Lead Beneficiary	7 - SYNPO
Deliverable Name	Report on the verified technology of MXene production and up-scaling findings		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	42	Work Package No	WP4

Description
Novel non-aggressive MXene binder-free and MXene-polymer composite production will be up-scaled.

Deliverable D4.2 – Report on three physical demonstrators of the multifunctional properties of PRPC with MXene-based layers

Deliverable Number	D4.2	Lead Beneficiary	8 - STIDO
Deliverable Name	Report on three physical demonstrators of the multifunctional properties of PRPC with MXene-based layers		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	48	Work Package No	WP4

Description
Report on three physical demonstrators of the multifunctional properties of PRPC with MXene-based layers

Deliverable D6.1 – Dissemination plan

Deliverable Number	D6.1	Lead Beneficiary	1 - KTU
Deliverable Name	Dissemination plan		
Type	R — Document, report	Dissemination Level	SEN - Sensitive
Due Date (month)	6	Work Package No	WP6

Description
Dissemination, exploitation, communication plans

Deliverable D7.1 – Data Management Plan (DMP)

Deliverable Number	D7.1	Lead Beneficiary	1 - KTU
Deliverable Name	Data Management Plan (DMP)		

Type	DMP — Data Management Plan	**Dissemination Level**	PU - Public
Due Date (month)	6	**Work Package No**	WP7

Description
Data Management Plan

Deliverable D7.2 – Progress Report

Deliverable Number	D7.2	**Lead Beneficiary**	1 - KTU
Deliverable Name	Progress Report		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	13	**Work Package No**	WP7

Description
Progress Report

Deliverable D7.3 – Mid-term meeting

Deliverable Number	D7.3	**Lead Beneficiary**	1 - KTU
Deliverable Name	Mid-term meeting		
Type	R — Document, report	**Dissemination Level**	SEN - Sensitive
Due Date (month)	18	**Work Package No**	WP7

Description
Mid-term meeting report

LIST OF MILESTONES

Milestones

Grant Preparation (Milestones screen) — Enter the info.

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
1	Kick-off meeting	WP7	1 - KTU	Kick-off meeting	1

LIST OF CRITICAL RISKS

Critical risks & risk management strategy

Grant Preparation (Critical Risks screen) — Enter the info.

Risk number	Description	Work Package No(s)	Proposed Mitigation Measures
1	External events beyond the project's control, such as political changes, economic downturns, or public health crises. Likelihood: M; Severity: M	WP1, WP3, WP6, WP7, WP4, WP2, WP5	Keeping project teams informed about potential external influences and the measures taken to manage them collaborating with institutional responsible departments.
2	The risk of the research implementation due to personal issues. Likelihood: L; Severity: H.	WP1, WP3, WP4, WP2	Continuous monitoring of project progress, adapting decisions beyond the initial plan in case of unfavourable outcomes, and potential inclusion of a new team member.
3	Technical failures (system breakdowns (cyberattack)), or inadequacies in the infrastructure. Likelihood: L; Severity: L	WP1, WP3, WP6, WP7, WP4, WP2, WP5	The research or communication activities will be conducted in partner institutions, or will be utilized in external institutions.
4	Delays in project timelines. Difficulties in finishing project on time. Likelihood: L; Severity: H	WP1, WP3, WP6, WP7, WP4, WP2, WP5	Fostering open communication within the project team to address challenges promptly. Discussing the possibility of new funding opportunities for continuing the research.
5	Challenges in collaboration between teams. Likelihood: L; Severity: M.	WP1, WP3, WP6,	Encouraging open communication, collaboration, and information sharing within the research groups.

Critical risks & risk management strategy

Grant Preparation (Critical Risks screen) — Enter the info.

Risk number	Description	Work Package No(s)	Proposed Mitigation Measures
		WP7, WP4, WP2, WP5	
6	Challenges in exfoliation of MXene nanoparticles. Likelihood: M; Severity: H	WP1, WP3, WP4, WP2	Explore alternative non-aggressive synthesis procedures not described in this proposal.
7	Challenges in non-aggressive synthesis of MXene. Likelihood: M; Severity: H	WP1, WP3, WP4, WP2	Explore alternative non-aggressive synthesis procedures not described in this proposal.
8	The MXene layers generated will lack multifunctional properties. Likelihood: L; Severity: H	WP1, WP3, WP4, WP2	Investigation of hybrid nanoparticle formulations for layers to attain the desired properties.
9	Delay in the implementation of secondments	WP7	1. Secondments' implementation will be monitored by a designated person at the level of each participant. At project level, the Coordinator will organise Skype meetings every 1-2 months to discuss the monitoring of secondments and collect any information about possible identified delays at participants' level, both at sending and hosting institutions. On the other hand, each Participant takes responsibility that the secondments take place as planned and reports immediately or maximum 2 months prior to the scheduled secondment any possible deviation to the Coordinator. 2. Once a potential delay is identified, action plans will be agreed at Consortium level or by the Steering Committee (where is the case). The Coordinator will inform REA about the solution found. 3. For secondments to third countries, the beneficiary will identify in time the human resources to be seconded and the necessity of visa. In order to avoid visa issues, administrative support and follow-up needs to be put in place several months prior to the scheduled secondment, so that the visa is obtained on time. 4. A chapter specifically dedicated to this risk and the method to implement upfront monitoring and continuous reporting will be included in the Consortium Agreement and in the Partnership Agreement accordingly. 5. staff turnover: all participants will identify additional personnel with the necessary experience, not intended initially to be seconded in the project work, so that the risk is minimized.

Critical risks & risk management strategy

Grant Preparation (Critical Risks screen) — Enter the info.

Risk number	Description	Work Package No(s)	Proposed Mitigation Measures
10	Withdrawal of participants	WP7	If possible, another participant from the consortium will carry out the tasks/WP of the withdrawing one. If not, a new entity with the same specific expertise could be included in the project upon agreement of REA.
11	Shortage of funding for third country partners	WP7	(Third country) associated partners not eligible for EU funding would ensure their own funding (e.g., national funds) and complete the transfer of knowledge for the activities they engaged in the project. A Partnership Agreement will be signed.

MSCA SE PARTNER EXCHANGES AND OVERALL FUNDED EXCHANGES

Partner exchanges

Summary of secondment months per sending partner (beneficiaries and associated partners)

Partner No	Partner Name	Country	Country Group	Academic Sector	Number of Secondment Months Period 1	Number of Secondment Months Period 2	Total Number of Secondment Months
1	KTU	LT	EU/AC	Y	22	20	42
2	LU	LV	EU/AC	Y	24	16	40
3	PISAS	SK	EU/AC	Y	15	10	25
4	VSCHT	CZ	EU/AC	Y	4	2	6
5	CNR	IT	EU/AC	Y	12	13	25
6	LTU	SE	EU/AC	Y	8	10	18
7	SYNPO	CZ	EU/AC	N	2	7	9
8	STIDO	LT	EU/AC	N	6	14	20
9	COMEC	IT	EU/AC	N	2	8	10
10	SA	LT	EU/AC	N	2	8	10

Overall funded exchanges

Summary of secondment months funded by the EU per beneficiary (as sending partner + seconded to partner)

Partner No	Partner Name	Country	Number of Secondment Months Period 1	Number of Secondment Months Period 2	Total Number of Secondment Months
1	KTU	LT	22	20	42

Overall funded exchanges

Summary of secondment months funded by the EU per beneficiary (as sending partner + seconded to partner)

Partner No	Partner Name	Country	Number of Secondment Months Period 1	Number of Secondment Months Period 2	Total Number of Secondment Months
2	LU	LV	24	16	40
3	PISAS	SK	15	10	25
4	VSCHT	CZ	4	2	6
5	CNR	IT	12	13	25
6	LTU	SE	8	10	18
7	SYNPO	CZ	2	7	9
8	STIDO	LT	6	14	20
9	COMEC	IT	2	8	10
10	SA	LT	2	8	10

1. **ANNEX 1**

Horizon Europe (HORIZON)

Description of the action (DoA)

DESCRIPTION OF THE ACTION (PART B)

History of Changes

History of Changes			
Version	**Date**	**change**	**Page**
1	11 June 2024	GAP • Clarifications in response to the shortcomings identified under ESR (Criterion Implementation) have been added	Page 23
2	24 July 2024	GAP: • Initially planned deliverables have been rationalized; Mandatory deliverables, risks and milestones have been added. • Clarifications in response to the shortcomings identified under ESR (Criterion Implementation) have been extended. • Ethics section has been added	Part A Page 22 Page 23

TABLE OF CONTENTS

1. Excellence

1.1. Quality and pertinence of the project's research and innovation objectives (and the extent to which they are ambitious, and go beyond the state of the art)

Introduction, objectives and overview of the research and innovation programme

The general challenge in the engineering of aeronautics, wind turbine, marine, or commercial transport structures is the development of strong, damage-tolerant, lightweight, and reliable materials and ensuing structures working under severe service conditions (extreme mechanical loads, high humidity, icing, etc.). Traditional fibre-reinforced plastic composites (FRPC) are an excellent solution for such applications. Due to the severe working conditions, it is necessary periodically to repair or replace FRPC parts. That not only increases the cost to the end-user but also reduces safety and increases pollution, as the issue of FRPC recycling is not yet fully solved. The technological breakthrough might emerge from the development of smart thin layers, functioning as interlayers or coatings. These layers, possessing excellent barrier and electrical properties, would protect FRPC structures from moisture and endow structures with highly beneficial multifunctional properties, thereby enhancing human safety and solving environmental issues.

The overall aim of the project is to provide innovative materials for extremely thin FRPC layers utilised as interlayers and/or coatings, along with their manufacturing technologies and tailoring to FRPC, focusing on the sustainable use of environmentally friendly materials, contribution to a circular economy, better performance, efficiency, quality, and cost savings in their end-user applications.

Recently, an innovative two-dimensional (2D) nanomaterial MXene was discovered[1]. A unique combination of semi-conductivity, hydrophilic surface, and excellent mechanical properties renders MXene as an attractive candidate for many technological applications. Moreover, the most promising MXene **$Ti_3C_2T_z$** is an **environmentally friendly** material, and according to recent research[2], its production can be achieved without the use of aggressive components.

The goal of the MIRACLES project is to develop **novel MXene-based layers for FRPC**, tailoring multifunctional properties for ensuing structures. The proposal defines these layers as thin interlayers and/or coatings.

The following research objectives are set to achieve the goal:

- **Development of new materials** for MXene-based layers of two types: *i*) binder-free and *ii*) MXene-polymer composites;
- **Theoretical modelling** for predictive analysis and optimisation of multifunctional properties of MXene-based layers;
- Experimental **testing** of FRPC samples for the **validation** of multifunctional properties of developed MXene-based layers;
- **Up-scaling** of novel non-aggressive MXene synthesis and exfoliation methods, and **demonstration** of multifunctional properties: heating, sensing, and barrier properties of MXene-based layers.

The objectives exhibit a highly **interdisciplinary** nature. The first objective requires deep knowledge in inorganic, organic, polymer, and molecular chemistry, as well as in applied and industrial chemistry; however, it also necessitates a contribution of expertise in materials engineering, mechanical and manufacturing engineering. The second and third are grounded in materials engineering, mechanical and manufacturing engineering, and production technology and process engineering, but also require knowledge in the fields of polymer chemistry, nanomaterials, and thin film research. The final one is based on the synergy of all these disciplines and facilitates the derivation and upscaling of the final outcome – innovative and smart MXene-based formulations for smart layers in FRPC structures with tailored multifunctional properties alongside technologies for their production.

Objectives of **MIRACLES** are **SMART**:
Specific — the project outcome is oriented on specific applications – FRPC structures;
Measurable — 2 types MXene-based formulations for FRPC layers will be provided and 3 demonstrators will prove their multifunctionality;
Achievable — previous experience in MXene research;
Realistic — highly qualified, balanced interdisciplinary team poses enough potential;
Time-bound — 4-years scheduled intensive research split into work

The **greatest impact** of this innovation will be achieved by making FRPC structures **safer**, **cleaner** and **cheaper**, so that they can be adopted in applications where the benefits of **local curing**, **de-icing**, **self-sensing**, **weight reduction** and **protection against moisture** can be seen.

Lightweight structures are increasingly necessary to meet current engineering requirements. The innovation of the project concerns the lighter weight of structural composites through **environmentally friendly** formulations,

[1] M. Naguib, *et al*. Two-Dimensional Nanocrystals Produced by Exfoliation of Ti_3AlC_2. Advanced Materials 23 (2011) 4248–4253.
[2] S. Iravani. MXenes and MXene-based (nano) structures: A perspective on greener synthesis and biomedical prospects. Ceramics International 48(17) (2022) 24144.

enabling **reduced energy consumption** and contributing to **reduced CO_2 emissions**. In the context of reducing energy consumption, the role of local curing technology is noteworthy. This technology has the potential to substitute traditional autoclave curing methods.

The MIRACLES will also offer an **eco-responsible** MXene-based materials for FRPC layers production since the MXene will be obtained by a much faster route and will also allow to avoid the use of hazardous reagents. This innovation can significantly enhance production time, avoiding intercalation, delamination, and reconcentration of the MXene particles in contrast to the previously known techniques. The overall MIRACLES concept, which defines the project's means based on the research objectives, desired result, and ends, is presented in Figure 1.1.

In addition to research objectives, objectives within the scope of the call are also established:

- **Inter-sectoral** and **interdisciplinary** consolidation and sharing of knowledge, competencies, and ideas between partners working in engineering and chemistry fields;
- Exchange of staff aimed to improve research-related and transferable skills, leading to increased **employability and career prospects** in the EU for both academic and industrial partners;
- Enhancing of **R&I capacity** among participating organisations;
- **Training and mobility** of EU researchers facilitating build-up of a new generation of engineering and chemistry researchers, as well as new direct communication channels between i) young and experienced researchers, ii) researchers focused on different approaches, and iii) researchers and industry representatives;
- **Integration** of scientific insights into an innovation-based industrial environment.

The objectives and contributions to the impact will be achieved through the cooperation of ten consortium members from Europe. Partners are endowed with complementary expertise and knowledge in Engineering and Chemical Sciences, and are able to develop and assess novel materials by characterisation, theoretical modelling, testing, validation, up-scaling and demonstrating the multifunctional properties. The consortium is well-balanced, presenting inter- and transdisciplinarity, complementarity, and synergy between industry and academia. By starting from TRL3, the project plans to grow forward to TRL6.

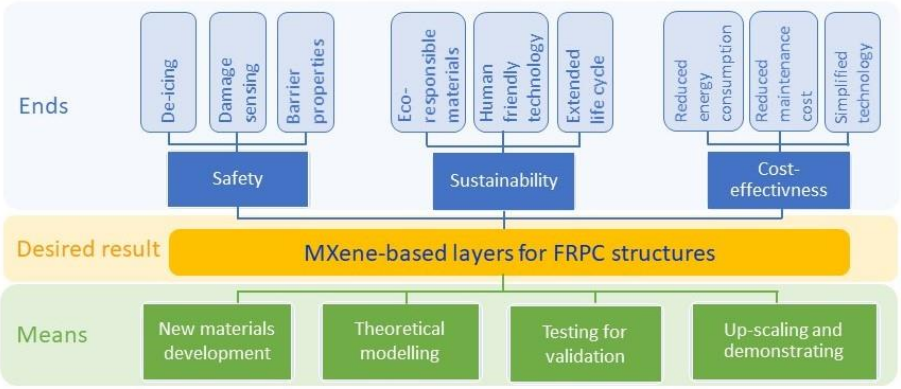

Figure 1.1. Overall concept of MIRACLES.

Pertinence and innovative aspects of the research programme

The EU has launched an ambitious action plan Green Deal with the target of making the EU climate neutral by 2050. According to the Composites Sustainability Report 2021, the European composite materials industry should contribute significantly to this, helping Europe to lead the way for the rest of the world. The idea of developing cleaner but no less efficient and advanced technologies for the production of structural FRPC based on scientific research is extremely relevant as it contributes directly to the EU goal. The MIRACLES project significantly contributes to this goal with a fundamentally innovative approach, utilizing the pioneering electrically conductive nanomaterial MXene. This approach enhances FRPC structures by improving safety, extending their life cycle, and ensuring cost-effectiveness.

Current state-of-the-art. Since the discovery of MXenes in 2011, transition metal carbide Ti_3C_2 has been the most researched particle, and till now, it is one of the best for various nanotechnology applications. A newly developed synthesis using HCl and LiF showed successful water-based delamination without ultrasonication and hazardous chemicals[3]. Nano-indentation results revealed higher elastic modulus, strength and electrical conductivity compared to its rival, graphene oxide (GO)[4]. Also, a recent study on multifunctional MXene nanocoatings showed good adhesion with epoxy-based polymers, high strain gauge factor, efficient Joule heating and stable strain sensitivity under cyclic deformations[5]. Therefore, MXenes are perspective material for innovative multifunctional nanolayer and coating applications using layer-by-layer (LbL) manufacturing processes[6]. LbL coating technology allows

[3] Lipatov A. *et al.* Effect of Synthesis on Quality, Electronic Properties and Environmental Stability of Individual Monolayer Ti_3C_2 MXene Flakes. Adv. Electron. Mater. 2 (2016) 1600255.
[4] Lipatov A. *et al.* Elastic properties of 2D Ti3C2Tx MXene monolayers and bilayers. Sci. Adv. 4 (2018) 1–7.
[5] Monastyreckis G. *et al.* Strain Sensing Coatings for Large Composite Structures Based on 2D MXene Nanoparticles. Sensors (2021), 21(7), 2378.
[6] Lee T. *et al.* Layer-by-Layer Assembly for Graphene-Based Multilayer Nanocomposites: Synthesis and Applications. Chem. Mater. 27 (2015) 3785–3796.

tailoring specific electromechanical properties, such as flexibility and conductivity, or electromagnetic interference shielding and barrier properties, based on the layered architecture of nanoparticles and polymers.

The de-icing systems for the wind and aviation industries should be designed with a particular geometry and withstand high mechanical loading and environmental effects. Current carbon fibre-based electrothermal de-icing systems for FRPC represent excessive energy usage and are heavy and costly to manufacture[7]. In contrast, MXene layers are easily processable and scalable due to their hydrophilicity and spray-coating processability. Additionally, using digitally controlled self-sensing MXene layers, specific ice-accumulated areas can be efficiently de-iced using local heating technology. The same principle of local heating could be applied to novel two-part composite adhesive joining based on interlaminar curing[8]. These features would result in significant weight reduction, lower energy consumption, and lower manufacturing costs.

Lastly, low amounts of MXenes can be introduced to the polymer matrix to improve the barrier properties from UV-aging and atmospheric etching. The horizontally aligned nanoflakes would act as a protective micro-barrier from permeating gases and small rain-acid molecules[9].

An attempt to find ongoing Horizon Europe projects on MXenes and their polymer composites (using CORDIS website) has resulted in several projects. The most relevant projects are 3D2DPrint, NANO2DAY, DyVirt, and GrapheneCore3. 3D2DPrint is dedicated to the integration of novel 2-dimensional nanomaterials (incl. MXenes) with novel additive fabrication techniques to develop a unique class of energy storage devices. The aim of DyVirt is to model the performance of novel engineering structures that operate in dynamic environments. Finally, GrapheneCore3 is focused on bringing innovative 2D nanoparticles (e.g., graphene and MXene) out of the lab and into commercial applications.

The finished H2020 project NANO2DAY and M-Era.net project Nano2Com implemented in collaboration between several partners of the current project proposal (KTU, LU, SYNPO, LTU, and PISAS) were aiming at the development of advanced multifunctional composites with outstanding electronic and mechanical properties by incorporation of novel MXene nanosheets into polymer matrixes.

No projects highlighting the development of smart MXene-based layers for FRPC were found. The MIRACLES is a first step in the rational design and systematic exploration of MXenes for structural applications with a major focus on the validation of their multifunctional performance (heating, sensing, and barrier properties). The advantage of the MIRACLES is in the combination of multidisciplinary and inter-sectoral collaborative research on the development and assessment of novel MXene-based layers contributing to the implementation of these concepts into industrial applications.

Progress beyond the state-of-the-art. Novel methods of MXene exfoliation and delamination will be explored together with the possibilities of reagent recycling using standard methods. These are highly important for scaling-up the MXene synthesis and reducing toxic compounds used in exfoliation/delamination processes. The standard methods for the MAX phase etching will be used as a starting point, where the possibilities of hydrofluoric acid and lithium recovery will be tested. The recovery of hydrofluoric acid will be explored using distillation in Teflon-based apparatus, and for the LiF based exfoliation mixtures, the recovery of lithium will be tested.

MXene strain and damage sensing layers still have a large area for improvement and need consistent development. Two of the key aspects towards industrial application are reproducibility and uniform layer formation. The project will explore an automated spray method with precisely controlled nanoparticle quality and spray yield. Layers sensitivity will be improved with the new LbL technology, introducing more flexible and responsive layers using different nanoparticle and polymer configurations. Also, the LbL technique will help to decrease layer's sensing degradation over time, which is another challenging aspect under harsh environmental conditions. Additionally, new surface treatment techniques such as temperature annealing, antioxidants, and various protective polymer coatings will be explored to increase stability further. Highlights of progress beyond the state-of-the-art are provided in Table 1.1.

Table 1.1. Highlights of the MIRACLES progress beyond the state-of-the-art.

Issues on the state-of-the-art	MIRACLES ambition beyond the state-of-the-art
$Ti_3C_2T_z$ MXenes are prepared from Ti_3AlC_2 MAX phase using harmful solvents, either HF or HCl and LiF for etching.	The MIRACLES will offer two strategies; firstly, a technology for recycling aggressive reagents obtained during the preparation of MXene; secondly, a new MXene synthesis technology that does not use hazardous reagents.

[7] Roy R. *et al.* Multiphysics anti-icing simulation of a CFRP composite wing structure embedded with thin etched-foil electrothermal heating films in glaze ice conditions. Composite Structures 276 (2021) 114441.

[8] Collinson M.G. *et al.* Development and implementation of direct electric cure of plain weave CFRP composites for aerospace. Composites Part A, 172 (2023) 107615

[9] Carey M. *et al*. MXene polymer nanocomposites: a review. Materials Today Advances 9 (2021) 100120.

The complex delamination process of the multi-layered MXenes does not guarantee sufficient quality.	The new delamination methods will significantly speed up and improve the delamination quality. Single-layer MXenes will have a sufficiently high aspect ratio, which will ensure good electrical conductivity not only in binder-free layers but also in MXene-polymer composite layers.
The high oxidation rate of MXene layer, insufficient stability and homogeneity.	The functionalisation by various functional groups on MXene surface methods to deal with oxidation insufficient stability of MXene will be developed. FRPC surface treatment technology will be presented to form homogeneous layers.
There is insufficient research demonstrating the use of MXene for smart layers to FRPC; only preliminary insights show promising results.	Fundamentally new technology for smart layers on FRPC structures will be proposed based on theoretical modelling, validated by experimental testing, up-scaled and demonstrated in a relevant environment.
Axial and local strain sensing of FRPC using fibre-optic sensors and strain gauges. Expensive and complicated system integration and inaccurate local damage assessment[10].	MXene-based layers will offer scalable, cheap and easily processed application procedures. The layers on the FRPC structure will act as a uniform, fully-coverage biaxial strain sensor with the ability to locate the damaged area.
Traditional carbon-fibre or metallic de-icing systems are expensive, heavy, and need specific integration during the manufacturing process.	The spray and print techniques will allow MXenes to be applied to existing and new structures. Additionally, developed layers will offer ultra-low thickness, weightless, efficient, and fast local de-icing with the ability to be easily repairable.
Traditional two-part composite curing technology requires large autoclaves, which are expensive and energy-consuming.	The newly developed local curing based on Joule-heating using MXene interlayers would cut energy consumption and allow for the easy processing of complex-shaped parts.

Key results of the MIRACLES project and innovation potential:

- Highly sensitive piezoresistive MXene-based layer for FRPC structure's health monitoring. **Complete area** coverage and **biaxial strain sensing** of the structure, when compared to local and uni-axial sensing obtained with traditional fibre-optic sensors and strain gauges.
- Localised **damage sensing** and composite's surface crack-growth tracking in real-time, when compared to only strain sensing and inaccurate damage assessment obtained with traditional fibre-optic sensors and strain gauges.
- More than **10 times FRPC weight reduction** compared to traditional carbon fibre-based de-icing systems. Introduction of easy modernisation of the existing structures using scalable spray methods and layers integration during the manufacturing process.
- **Up to 30% reduction in energy consumption** compared to existing de-icing systems, and the innovative ability to track ice formation and perform localised heating for curing.
- Barrier properties improved that **reduce water absorption rate up to 3 times** (estimation for the composite layer with 1.0 wt. % of MXene) compared to traditional weatherproof paints.

The innovation potential of smart MXene-based layers developed through the project activities will be represented with new multifunctional abilities and improved barrier properties (Fig. 1.2). The expected results, such as damage sensing and efficient de-icing, are of great scientific and practical importance because they improve the structure's lifespan and reliability. Knowledge gained in the MIRACLES will allow the opportunity to show layers practical use in previously unrealised ways. Examples of such layers can be related to the aviation and wind energy markets, where the structure's durability is the primary user's goal.

The MIRACLES team realises that the expected results are quite ambitious since very few investigations on MXene-based layers for FRPC structures can be found in the literature. Undoubtedly, it increases the potential risks of the project realisation, but at the same time – strongly increases the level of innovation. The rapid growth of the innovation potential is expected with at least one reasonable application in the industry, which right now is achievable due to already collected reliable

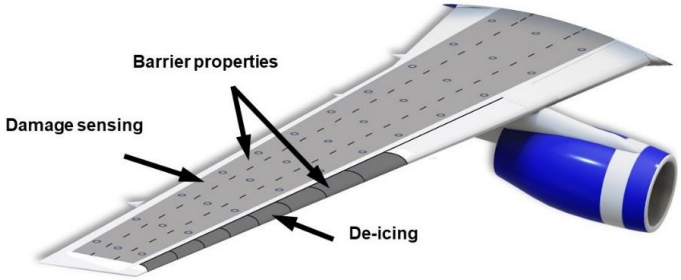

Figure 1.2. MXene-based layers on a wing.

[10] Kaewniam P. *et al*. Recent advances in damage detection of wind turbine blades: A state-of-the-art review. Renewable and Sustainable Energy Reviews 167 (2022) 112723.

data of MXene nanoparticles, their synthesis and properties over the last 10 years. The MIRACLES team will take the role of pioneers to introduce the new practical applications of MXene-based layers to the scientific and industrial community of structural FRPC.

1.2. Soundness of the proposed methodology (including international, interdisciplinary and inter-sectoral approaches, consideration of the gender dimension and other diversity aspects if relevant for the research project, and the quality of open science practices)

Overall methodology

New materials development**.** The **MXene binder-free formulation** preparation will be based on the MXene synthesis methods which will primarily use standard procedures to provide materials at the project start. For this, hydrofluoric acid (HF) and hydrochloric acid (HCl)/lithium fluoride (LiF) based exfoliation/delamination methods will be simultaneously explored for possible recycling of reagents which are used in large access like HF or are highly valuable like LiF. The methods for the recycling of valuable (LiF) or toxic (HF) chemicals will be elaborated and tested. In this first step, different delamination agents will be tested, including tetraalkylammonium cations with various lengths of alkyl chains, to estimate their influence on the yield and degree of exfoliation. Alternative methods will be developed for exfoliation, and their scalability will be explored. The alternative exfoliation routes will be based on direct reaction with a controlled amount of free halide in organic solvents, which can be easily recycled by distillation. The second route will be based on molten salt reaction using various low-temperature systems, including $ZnCl_2$ and its eutectic mixtures with other chlorides. Alternatively, other molten salt systems will be explored, including $ZnCl_2/CuCl_2$ mixtures, $AlCl_3$, $FeCl_3$, $SnCl_2$ and $SbCl_3/SbCl_5$ based mixtures. The addition of alkaline and alkaline earth halides will be explored in order to reduce the melting point of the etchant and also to reduce its vapour pressure which can be very high in a molten state. Subsequent separation from the reaction mixture will be performed in both organic solvents and water-based solvents. The use of organic solvents will allow a high degree of halogen termination of MXene for further functionalisation, while water-based treatment will partially hydrolyse halogen-terminated MXene and substitute the surface with hydroxyls.

New formulations of **MXene-polymer composites** will be designed and prepared. Two types of polymeric matrices will be investigated: waterborne and solvent-borne systems. The priority will be the waterborne systems, which are industrially friendly for production upscale. The polymeric matrices will be based on the most used types of polymer binders, e. g., epoxy, acrylate, polyurethane or silane. Epoxy systems will be chosen based on the properties of prepared modified Ti_3CT_z particles. Waterborne systems will be prepared by emulsion or miniemulsion polymerisation of chosen polymeric systems in the presence of modified $Ti_3C_2T_z$. In the literature there already are some successful examples of waterborne systems containing MXenes used in various coating applications [11, 12]. However, the stability and upscaling of the MXene based coatings were not addressed. The novelty of MIRACLES will be that stable modified $Ti_3C_2T_z$ MXene will be prepared, and it could be then upscaled for industrial needs.In order to improve the compatibility of MXene with polymer matrix, surface functionalisation will be used for the introduction of various functional groups on the surface.

The **integration/deposition of the MXene-based layers** into/on FRPC will be developed. Three different approaches will be investigated. The first will involve the deposition of a binder-free MXene formulation as an extremely thin additional layer within the stacking sequence or onto the FRPC surface by direct spraying the solution, forming a continuous homogeneous layer. The second strategy will explore a new method of the aerosol spray using an industrial-grade 3D jet printer to distribute the layer according to specific patterns, thereby achieving desired sensing/functional features of FRPC (Fig. 1.3). This project will also consider the pattern design and optimisation. Compared with other 3D printing technologies, this new method employs direct solution printing technology, which extrudes solution directly through a nozzle and then deposits it layer by layer on a substrate. Surface treatment of prepreg will be investigated to enhance stability and ensure high quality. The third method will be aimed to deposit thin stable and homogenous MXene-polymer layer. The technology based on the different methods (e.g., spray, doctor-blade, ect.) will be developed. Additionally, several layer LbL configurations will be tested with the most-suitable polymer, which will act as a binder between nanoparticle 2D blocks in order to improve coatings durability, oxidation stability and barrier properties.

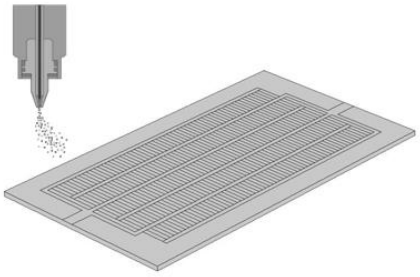

Figure 1.3. Patterns print on FRPC substrates.

[11] Ma et al. Bio-based Waterborne Poly(Vanillin-Butyl Acrylate)/MXene Coatings for Leather with Desired Warmth Retention and Antibacterial Properties. Available online 30 June 2023, https://doi.org/10.1016/j.eng.2023.06.005.

[12] Wan et al. Substrate-Independent Ti3C2Tx MXene Waterborne Paint for Terahertz Absorption and Shielding. ACS Nano, 15 (2021), 13646-13652.

The characterisation of new materials. X-ray photoelectron spectroscopy (XPS) has been shown to be a very fast and accurate technique to evaluate the chemical structure and degree of degradation of $Ti_3C_2T_z$ MXenes[13]. The diverse functionalisation of the $Ti_3C_2T_z$ end groups will be characterised by XPS and a stability study of prepared 2D nanomaterials will be performed. Characterising the wettability of the prepared MXenes is very important for the correct design of the multicomponent system. Therefore, the wettability behaviour using receding and advancing contact angle measurements using different liquids[14] will be studied in detail. Characterisation of MXene-based formulations and layers by XPS, Fourier transformed infrared spectroscopy (FTIR), Raman spectroscopy, and microscopy methods in combination with elemental analysis, including Scanning electron microscopy with Energy dispersive spectroscopy (SEM/EDS) and Transmission electron microscopy (TEM) coupled with EDS and Energy electron loss spectroscopy (EELS) will be performed. Thermal stability will be explored by Differential scanning coulometry (DSC) with Thermogravimetric analysis coupled with Mass spectrometry (TGA-MS) methods and homogeneous functionalisation as well as composite incorporation by microscopy methods such as Atomic force microscopy (AFM), TEM, SEM, electrochemical microscopy. Mechanical properties of polymer composites will be tested by Dynamic mechanical analyser (DMA). Nanomechanical properties and surface morphology of prepared heterostructured coatings will be studied by nanoindentation.

Theoretical modelling. Analytical and numerical modelling will be applied for the predictive analysis and optimisation of smart properties of MXene-based layers containing 2D-shaped nanoparticles. **Joule heating and Barrier properties modelling** will be performed in combination of analytical one-dimensional (1D) heat and moisture transport through the layer thickness and following finite element modelling (FEM) of the local heat and water transfer in the system of the layer (coating) and substrate (FRPC). Analytical modelling will be based on the calculation of electrical current density, heat and water flows and modelled conductivity and permeability of the layer (coating). Classical 1D Fourier equations will be applied for heat and water transfer modelling to define the effective properties of composite layers with nanoparticles by inverse calculation.

Damage identification modelling. Electromechanical modelling with damage identification based on the localised electrical potential gradient (EPG) will be investigated using the finite element model updating technique (FEMU). The procedure will be divided into two stages. In the first stage, numerical analysis will be carried out to define the micromechanical fracture behaviour of MXene and LbL-based nanolayers with the in-situ subroutine of EPG at different loading steps. The investigation will provide strain gauge effect and damage sensing capability on different interlaminar materials, geometry configuration, and LbL architecture. In the second stage, the FEMU procedure will be implemented using a Surface Response Optimisation technique, incorporating various design approaches such as Central Composite Design and Sparse Grid Initialization. Additionally, optimisation methods such as Genetic Aggregation, Neural Networks, and Multi-Objective Genetic Algorithms are employed in this stage. The utilisation of optimisation techniques enhances the accuracy of the FEMU process, allowing for a more precise identification of the damage. Through the exploration of design approaches and optimisation methods, the computational model will be fine-tuned with experimental data to achieve optimal correlation with real-world conditions.

Testing for validation. The **de-icing tests** and analyses will examine the thermal performance of new FRPC materials, augmented with MXene-based layers. Emphasis will be placed on the Joule heating effect, specifically to validate these layers for de-icing uses in FRPC structures. The effectiveness of these materials in ice removal or prevention will be thoroughly proven and validated. This will involve thermal imaging under direct current (DC) to evaluate heat distribution across the sample. Furthermore, the investigation will include monitoring the average temperature increase of the coating relative to power density and duration.

Local curing tests. Characterisation of localised curing may involve various techniques to fully understand the properties of the cured material. The choice of methods depends on the material type, application, and the volume of polymer cured. Localised curing will be characterised to evaluate the efficiency of the MXene-based layer, focusing on cure degree and material quality. The key factors for such characterisation include: uniformity of cure to assess the consistency of material properties over the whole surface of the specimen/structure; depth of cure to ensure that polymerisation occurs through the thickness of the specimen/structure; temperature profile and duration of the curing to be able to optimise the manufacturing process and avoid material degradation due to overheating; geometrical (e.g. distortions) and thermal stability (e.g. coefficient of thermal expansion (CTE) and glass transition temperature (T_g)) as well as mechanical properties of the cured polymer; the durability of the material over long time period (including moisture uptake). If localised curing is a primary function, these tests are crucial in early material development stages. The first test to consider for the characterisation of the localised curing is high resolution thermography (HTR) as it can provide information about variation of the temperature on the surface of the specimen/structure which is particularly useful for monitoring heat distribution during the curing. The output of this will be the temperature profile during the curing as well as in cured material. Based on this output uniformity of curing, curing time will be evaluated and possible defects will be identified. To complement this information DSC, TGA and DMA tests can be carried

[13] Micusik et al. Aging of 2D MXene nanoparticles in air: An XPS and TEM study. Applied Surface Science, 610 (2023), 155531.
[14] Machata et al. Wettability of MXene. Journal of Colloid and Interface Science, 622 (2022) 759–768.

out to quantify degree of cure and other properties of produced material (in this case samples will be randomly taken across the whole volume of the specimen/structure). To make better assessment of mechanical properties of materials, in particularly in the areas where possible defects have been detected, the nano-indentation tests can be performed.

Strain sensing tests. The optimal electrical properties of layers required for self-sensing strain and damage detection in the composites will be estimated through the experimental investigation of the MXene formulations and various composite surface treatment technologies. The experimental validation of the MXene-based layers suitability to sense the strain and damage will be performed by testing FRPC samples with embedded interlayers or deposited coatings under static, cycling, and impact loadings and monitoring the electromechanical behaviour of the MXene-based coating taking into account environmental conditions. Interlaminar fracture toughness tests will also be employed to explore the possibilities of detecting delamination damage. Additionally, various artificial defects such as scratches, notches, cuts, and dents will be created in FRP composites to investigate the likelihood of detecting such damages.

Investigation of barrier properties in the coating under different relative humidity on samples of the new MXene-based materials developed for coatings will be performed on the coating-FRPC substrate systems. The model parameters defined will provide experimental testing feedback on modelling and its validation. 1D water diffusion process will be realised and implemented in a humid environment choosing specific sample geometry.

Up-scaling and demonstration. **Optimised production of MXenes** will contribute to the integration of scientific knowledge into an innovation-based industrial environment through the up-scaling of novel non-aggressive MXene synthesis and exfoliation methods. In first stage the research will focus on optimisation of conditions for various molten salt and free halogen exfoliation methods. The main aim will be the degree of MAX phase exfoliation to have maximal yield of monolayer formation as well as minimisation of use of reagents especially transition metal halides. The up-scaling experiments will be dominantly focused on green methods; the possibilities of recycling and re-use of hazard materials will be tested as well. Molten salt experiments will be performed in batch reactor and various ratio of transition metal halides and eutectic mixtures of alkali metal and alkaline earth metals halogens will be used to reduce reaction temperature and amount of used transition metal halide. The other method will be based on selective etching of aluminium by free halogens using extraction-based system. As an alternative the batch solvothermal reactors will be used.

Optimisation of MXene-polymer composite materials production will primarily focus on the up-scaling of the dispersion procedure and on the optimisation of MXene introduction into the polymer matrix. Another possibility will be the preparation of MXene concentrates and their subsequent introduction into the polymer matrix. Optimisation of the process of applying composite materials on selected substrates, including substrates with a structured surface, with regard to the required final properties will also be involved.

Demonstrator for Joule heating applications Recently, the KTU team has conducted thermal behaviour tests on FRPC coated with pure MXene nanoparticles (Figure 1.4[15].). It was observed that the temperature distribution in the MXene coating is quite uniform, even when using a manual spraying method. The coating could heat up to 50 °C in 120 s. This is a very promising result, and therefore, by creating advanced formulations and using sophisticated FRPC production methods – applying jet printing or ultrasonic automatic spraying – a demonstrator will be produced that exhibits even more advanced heating technology and ability to de-ice.

The concept of **demonstrator for sensing applications** is shown in Figure 1.5. The demonstrator will consist of a fabricated FRPC plate, embedding MXene-based layers developed in the project, and an integrated electronics system that enables monitoring of the FRPC's deformation behaviour on a computer. The demonstrator will be connected to fatigue or impact loading infrastructures. Experiencing mechanical deformations, the MXene nanoparticles present in the layers will be disrupted, consequently altering their electrical parameters, which will be recorded with the aid of electronics. This will enable strain sensing of the FRPC. For such a demonstrator, MATLAB coding will be developed, thereby optimizing the monitoring efficiency.

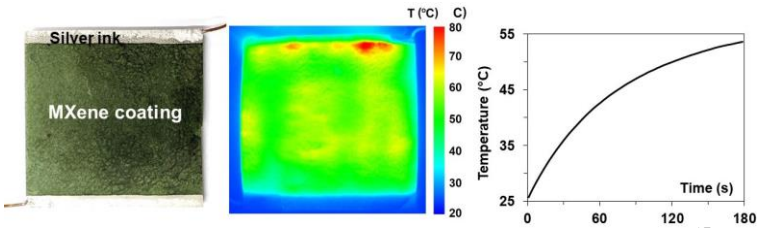

Figure 1.4. Thermal behaviour of pure MXene coating[15]

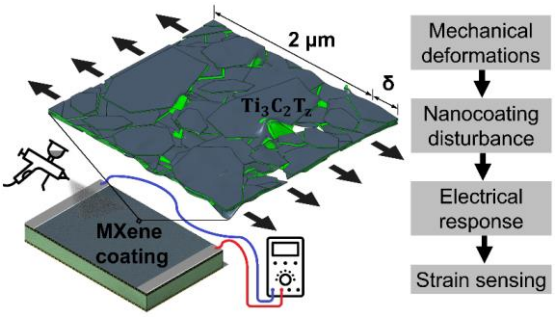

Figure 1.5. Strain sensing concept.

A demonstrator of improved barrier properties will be developed to illustrate reduced water permittivity through the developed coating due to MXene protective properties. The demonstrator will consist of

[15] Results were published in Proceedings of the 20th European Conference on Composite Materials, ECCM20. 26-30 June, 2022, Lausanne, Switzerland.

a fabricated FRPC coated with MXene-based layers developed in the project and an electronics sensor integrated into the testing cell. The sensor monitors water flow through the FRPC with coating and will be connected to a computer by wireless connection.

Integration of methods and disciplines to pursue the objectives

It often happens that researchers, deeply engaged in their fields, create remarkable innovations. However, these innovations sometimes remain unapplied because they do not meet the needs of other scientific disciplines, industries, or consumers. The MIRACLES project is designed to ensure that most scientific research is conducted by creating interdisciplinary teams. These teams comprehensively assess the need and benefit of the research from all possible perspectives.

KTU, LU, and LTU, with their background in materials engineering, mechanical and manufacturing engineering (G3 Level 1 keywords group according to "MSCA Keywords" [16]), will lead WP2 and WP3 tasks. These tasks involve theoretical modelling of Joule heating, damage identification, and barrier properties, as well as experimental testing for de-icing, local curing, strain and damage sensing, and barrier properties validation. However, having engineering knowledge and a clear understanding of the mechanical, electrical, and thermal properties required by newly developed materials, they will significantly contribute to WP1, collaborating with VSCHT (C1), PISAS (C2), and CNR (C4) in characterising the electrical and mechanical behaviour of synthesized MXene, MXene-based binder-free or MXene-polymer composite layers, and assessing their suitability for further use in project tasks. Also, KTU, LU, and LTU will analyse thermal imaging to check layer integrity and uniformity, investigate adhesive properties between the layer and substrate, wettability, and other characteristics to evaluate the formulation's suitability for subsequent tasks.

VSCHT, representing the inorganic chemistry field (C1), will be responsible for WP1 tasks on MXene synthesis and exfoliation, as well as the development of binder-free MXene formulation. VSCHT's knowledge will also be needed in the task of development of MXene-polymer composite (PISAS (C2) leads), where concentrated inorganic water-born and solvent-born MXene will be produced before introducing MXene into polymeric matrices.

PISAS represents organic, polymer, and molecular chemistry (C2) and is responsible in the project for the state-of-the-art mapping of MXene formulations and the development of MXene-polymer composite. The knowledge in polymer chemistry will also be required in MXene synthesis and exfoliation (VSCHT leads), as there will be a need to assess the compatibility of synthesized MXene nanoparticles with polymeric matrices and the optimization of MXene terminal functional groups according to potential chemical bonds in polymeric matrices. Here, PISAS can provide an assessment of the newly synthesized MXene's suitability for further project objectives. PISAS's assistance will be necessary in the characterisation of new materials (CNR (C4) leads), as PISAS will have the competencies to produce samples for MXene-polymer composite characterisation and investigation under various characterisation methods. Finally, PISAS will contribute its knowledge to de-icing tests (KTU leads), assisting in preparing samples by chemical treatment of the polymeric FRPC or prepreg surface.

CNR represents C4 applied and industrial chemistry and has extensive experience in 2D materials, nanochemistry, thin films, and materials for sensors. Therefore, CNR will lead a task in the characterisation of new materials. Moreover, CNR's knowledge base will be necessary in assisting PISAS in creating a mapping of MXene formulations and assessing a broad spectrum of applications, as well as assisting VSCHT under the development of binder-free MXene formulation, as knowledge on the technology of ultra-thin, stable, and homogeneous MXene nanolayer deposition on prepreg or FRPC substrates by different methods will be required. In WP2, the competencies of KTU and LU will need to be supplemented by CNR's knowledge and technical capabilities on the preparation of materials samples for theoretical model input data for optimal real-world correlation and structural data collection through analysing SEM and TEM results. It is also planned that CNR will contribute to local curing tests, led by LTU, as CNR will carry out 2D MXene deposition on the substrates using the LbL technique.

The interdisciplinary secondments of industrial partners will be no less significant. Industrial partners will primarily work on WP4 up-scaling and demonstrating. SYNPO, representing C4 applied and industrial chemistry, will be responsible for the up-scaling production of MXenes and MXene-polymer composite materials. STIDO and COMEC represent G3 products and processes engineering and are the final consumers of the innovations developed in this project, as their production is intended for the manufacturing of structural FRPC. The industrial G3 partners will be responsible for the demonstration of the multifunctional properties of MXene-based layers in FRPC. Therefore, the secondments of SYNPO, STIDO and COMEC will facilitate a comprehensive execution of these tasks through their secondments with each other.

Gender dimension and other diversity aspects

The MIRACLES project's research content does not have gender or equality relevance, and the results are **exploitable** irrespective of the end users' gender. Research focusses predominantly on the synthesis, characterisation, and application of advanced materials, with a main emphasis on enhancing the performance and functionality of

[16] Level 1 keywords C1, C2, C4, and G3 according to MSCA KEYWORDS

FRPC. Therefore, the activities of the MIRACLES project are primarily focused on achieving novel materials rather than addressing gender-specific dimensions. However, the **impact** of these innovations will be consistent across different genders.

The intermediate and final project results will be openly accessible to everyone, irrespective of gender, with the purpose of facilitating their **exploitation**. Project outcomes will be **disseminated** and **communicated** in a manner that reaches and engages a diverse audience. The presentations and communication channels will be chosen to be inclusive and accessible to individuals of all genders. This will help create awareness and interest among a broader community.

The consortium will promote **diversity** through the encouragement of interdisciplinary collaboration throughout the **implementation** of the WPs. Diverse perspectives and expertise from researchers at different career stages and backgrounds will be encouraged. Integrating gender and **diversity** aspects will lead to the creation of an inclusive and equitable research environment, thus increasing the potential progress of MXene-based layers for the FRPC.

Open science practices

All consortium partners will adhere to Horizon Europe mandatory and recommended open science principles by implementing the following practices.

During the project the research data will be managed in line with the FAIR principles. The comprehensive explanation of FAIR research data management can be found in the subsequent section.

Both Golden and Green Open Access (OA) models will be used for all scientific publications in order to make research accessible for researchers, industry and citizens. Additionally, pre-print or post-print of manuscripts will be deposited in OA repositories straight before submission (*arXiv*, *ChemRxiv*) or after the acceptation (*Zenodo*).

To validate the scientific publications and enhance the transparency and robustness of scientific research, supplementary files offering research outputs (such as modelling algorithms, materials preparation protocols) will be used in OA repositories.

With the development of three demonstrators to validate the multifunctionality of the developed FRPC with MXene-based layers, there will be an excellent opportunity to physically demonstrate project results on **industrial fairs** like famous Hannover Messe and JEC Composite Show, also various **citizen science** activities or events (e. g. MSCA-Science is Wonderful, Research Night, etc.). Additionally, the operation of these demonstrators will be captured on video, and this footage will be placed to OA repositories and elsewhere (e.g., webpage, social networks) to further reinforce the validation of project findings.

Research data management and management of other research outputs

The specific research data and research outputs management plan (DMP) will be developed at the very beginning of the project. The key **FAIR** aspects of this plan are presented here and will be further expanded and detailed.

In the development of new MXene-based materials, characterisation, theoretical modelling, experimental testing, validation of multifunctional properties of developed layers, production up-scaling, and demonstration, different data and research output sets will be generated and collected. The file formats of data/output will ensure the **long-term usability**. These formats will be as follows: tests results plotted in data sheet files (tabular data) – .csv, .xls/.xlsx, .opj, .opju; SEM micrographs, X-ray diffractograms, and AFM images, spectroscopic data from XPS, IR, Raman pictures (image data) – .jpeg, .jpg, .gif, .tif, .tiff, .png, .pdf; reports (textual data) – .rtf, .txt, .xml, .doc/.docx; video data – .mp4, and others. The planed volume of data/output set will be up to 50 GB. Data/output files' naming conventions will be set as well.

All data/outputs that are decided not to contravene **intellectual property rights** (IPR) will be made open, **no later than** when scientific articles based on them are published.

To make data/output accessible for project partners, they will be stored in a shared folder website (cloud storage). Data/output that can be open for everybody (which accepted as accurate, reliable and useful) will be shared and/or preserved on **trusted free-of-charges OA repository** (e.g., *Zenodo* or similar), herewith, the copies of files will be saved and restored, if necessary. To make data/output easier to find and access, files will be stored along with accompanying **metadata** (in line with standards offered by the Research Data Alliance), using **Digital Object Identifiers** (DOIs), "**readme**" text files, data **abstract**, and **keywords**, thus making the data/output as findable and accessible as possible. Repositories, which exemplifies interoperability through its adherence to multiple standard metadata formats will be selected. This will allow data/output to be easily integrated and utilised across different systems and platforms, enhancing their re-usability in diverse research and data-sharing contexts. To increase re-usability, CC-BY license for data files will be used as well. The metadata will be licensed under CC0.

KTU will be **responsible** for research data management and management of research outputs. A specific person from KTU team will be dedicated as a data manager. KTU will prepare and, if necessary, update the DMP, inform and consult all partners about OA policies and rules. Each partner separately will be responsible for their data/output capture, metadata production, data/output quality, storage and backup, data/output archiving, and sharing.

Currently, it is already established that data storage in "the cloud" or trusted repositories is reliably **secure**. Before the data appears there, it will be stored on personal computers. Storing data on laptops, computer hard drives, or external storage devices alone could be risky. Partners will be required to use passwords on their computers. MIRACLES data/output will not be sensitive to personal data, politically sensitive information, or trade secrets, but the data management will comply with the ISO 27001 standard. Additionally, all possible **ethical issues** regarding data management and management of other research outputs will be taken into account.

1.3. Quality of the proposed interaction between the participating organisations in light of the research and innovation objectives

Contribution of each participating organisation in the activities planned

The expertise of the consortium partners covers the wide spectrum of research challenges addressed by the project and offers a fertile environment for training and learning. The contribution of the partners to research objectives participating and leading project tasks are given in Table 1.4.

Table 1.4 – Contribution of the partners to research objectives through participation in specific tasks

Contribution of partners in research task **– Participants, X - leader**	**Academia**						**Industry**			
	KTU	LU	PISAS	VSCHT	CNR	LTU	SYNPO	STIDO	COME	SA
T1.1 State-of-the-art mapping of MXene formulations			X							
T1.2 MXene synthesis and exfoliation				X						
T1.3 Development of binder-free MXene formulation for layers				X						
T1.4 Development of MXene-polymer composite for layers			X							
T1.5 Characterisation of new materials					X					
T2.1 Joule heating modelling		X								
T2.2 Damage identification modelling	X									
T2.3 Barrier properties modelling		X								
T3.1 De-icing tests	X									
T3.2 Local curing testing						X				
T3.3 Strain sensing tests						X				
T3.4 Investigation of barrier properties		X								
T4.1 Optimized production of MXenes with contr. surface funct.							X			
T4.2 Optimized production of MXene-polymer comp. materials							X			
T4.3 Demonstrator for Joule heating applications								X		
T4.4 Demonstrator for sensing applications									X	
T4.5 Demonstrator of improved barrier properties										X

The majority of all the partners have already participated in previous/ongoing MCSA projects for the staff exchange or collaborated with each other in other EU and national funded projects. This allows for an effective and easy establishment of networking for knowledge sharing within the consortium. All partners will be involved in the scheme of staff exchange through secondments

Knowledge transfer (WP5) and communication, exploitation, and dissemination (WP6) activities are planned for every partner as well.

Justification of the main networking activities

The consortium will primarily carry out four types of networking activities to share knowledge (WP5). Throughout the project, secondees will have the opportunity to enhance their skills by gaining both intersectional and interdisciplinary knowledge through secondments. In this case, at least two project partners will have the opportunity to share their knowledge. It may happen that the host accepts more than one organization at the same time. Then, it will be particularly effective to organise half or full-day research-based training, industrial-based training, or seminars (this will include sharing knowledge necessary to perform experimental tasks, training on the techniques, data interpretation, and safety procedures). Additionally, project partners who are geographically nearby will have

possibility to join such events. In this way, events organised with the participation of secondees, the host, and sometimes others will be very efficient and not require significant resources for travel, accommodation, etc.

Two training schools will be organized during the project, aimed not only at doctoral candidates and postdocs participating in the project but also at external young researchers, including students of all study levels. The first school will be related to chemistry area, with special focus on MXene research, non-aggressive chemical synthesis methods, and the avoidance of harmful reagents. The school will be organized by PISAS, VSCHT, CNR, representing the field of chemistry. The other school will focus on engineering sciences, mostly on MXene application for smart FRPC, and will be organised by KTU, LU, and LTU partners. The final themes and lecturers of both schools will be discussed and decided at the beginning of the project and carefully planned. The first school will be organised in M12 and the second in M36. Each school will last three days and will be timed to coincide with the consortium's annual meetings (hosted by the same organization as the annual meetings) to optimize travel costs, which are also related to aviation CO_2 emissions. Beside training elements, time (ca. 20 %) will be reserved for network activities only. Depending on the weather, common activities like sightseeing, bicycle tours, barbecues or visiting typical sights and regions will be conducted to encourage a free exchange of thoughts and to strengthen the team building experience of the network.

Two MIRACLES workshops will be organized. The first will be online workshop in M6. During it, speakers with high experience in the field of open science practices will be invited to share their knowledge. Not only all participants of the MIRACLES project but also other employees of the participating organisations will be invited to this workshop, to broadly share this practice. The second workshop will be scientific and will take place at the end of the project, during an in-person closing meeting of the project partners around month M48. During this workshop, doctoral candidates and postdocs will present detailed presentations demonstrating their results achieved during the MIRACLES project. Such a workshop could last half a working day.

An event on entrepreneurship experience for young researchers will be organised in month M24 during the annual consortium meeting. Industrial partners SYNPO, STIDO, COMEC, and SA will conduct training on the challenges of establishing, managing, and developing a business. STIDO will moderate a discussion involving participants from all project partners. This will enhance motivation and knowledge to exploit research results through product development.

2. Impact

2.1. Developing new and lasting research collaborations, achieving transfer of knowledge between participating organisations and contribution to improving research and innovation potential at the European and global level

Describe the development and sustainability of new and lasting research collaborations

Secondments, networking activities and knowledge transfer are key activities that promote and develop sustainable collaborations within the project consortium.

The secondments will allow fellows within the project to gain experience by working in various environments, as both interdisciplinary, same-sectorial, and inter-sectoral international secondments are planned. This experience will be achieved by getting familiar with different approaches to problem-solving, learning new methods, and having an opportunity to interact with colleagues in various countries within different branches and disciplines.

Networking will facilitate the connection of project partners with each other within the core consortium and with experts, potential collaborators outside of the project and other stakeholders. The planned network activities of the project are workshops, seminars, project meetings, social events, etc. The networking will result in the exchange of ideas, best practices and, ultimately, new collaborations. It is anticipated that these activities will lead to building personal relationships within the consortium and beyond, which will be kept active even after the project ends.

The main result of the knowledge transfer is exchanging information, expertise, and valuable skills between project participants. That will occur naturally during the secondments and networking activities. The knowledge transfer process will be facilitated by formal mechanisms planned within the project (e.g., training schools, workshops, entrepreneurship events) and informal communications, like mentorship, learning from other peers, teaching and supervising students. The knowledge transfer will complement the strength of other project participants and provide them with new capabilities, which, of course, is one of the project's main objectives.

The sustainability of the project (in terms of continuation) is ensured by the fact that most of the consortium partners have already been working together on projects during the last five years. Moreover, during the previous ten years the collaboration within the consortium members includes but is not limited to the preparation and submission of 10 EU scientific projects, current participation in 2 international projects: MSCA-RISE COAT4LIFE (LU, SYNPO, and KTU), and BLACKSENS (PISAS and VSCHT), publication of dozens joint scientific papers (LU, LTU, KTU, PISAS, SYNPO, CNR, VSCHT), and participating numerous conferences. This long-lasting collaboration will be

expanded and developed via secondments and networking activities. Thus, the fellows will improve their existing scientific competencies and acquire new cross-cutting skills to better address future employers' needs. Moreover, upon such collaboration, the fellows will be prepared for a career in both sectors, including the development of their entrepreneurial skills, which, to a great extent, corresponds to EU recommendations regarding the mobility of researchers between academia and industry.

During the project implementation, the consortium will focus on building and continuing collaboration post-project by leveraging synergies with the key EU programs such as Horizon, M-Era.Net, COST, etc. The consortium members will seek new opportunities for partnership within these programs. This collaboration will go on after the project ends, and this will be motivated by professional (and also personal) links built up during the project. Cooperation within the project (particularly during the secondments) will be a solid platform to produce joint scientific publications where original results obtained during the project will be presented. A more detailed strategy for the future self-sustainability of the partnership after the end of the project will be developed during the project. Several networking platforms (e.g., project website, Facebook account, and professional network media like LinkedIn and ResearchGate) will be used continuously to communicate with consortium partners during and after the completion of the project. Thus, the self-sustainability of the partnership will be ensured, contributing to research and innovation within Europe after the end of the project.

Describe how the project will generate knowledge transfer

To ensure the higher impact, every secondment is planned in such a way that it is in-line with the overall project objectives and contributes to the transfer of knowledge, gaining new expertise and strengthening collaboration. To make it most effective, before a secondment, the specific knowledge and skills that participants at the host institution will gain will be identified. On the other hand, the contributor of knowledge transfer (host institution or particular staff member) is clearly defined. The selection of such a host is based on the relevant expertise, capacity, and willingness to be actively involved in teaching and learning. The actual mechanisms for knowledge transfer are based on well-defined mentorship practices and involve joint projects, training sessions, and hands-on experience with feedback sessions organized on a regular basis to monitor progress and make sure that there is no miscommunication. To ensure that the gained knowledge is successfully transferred back to the home institution, the sharing of experience (and its integration into the home organization) will be carried out. This will be done by providing an opportunity for staff members after the secondment to share their experiences, apply new skills and present research findings to colleagues and stakeholders. The effectiveness of the knowledge transfer has to be evaluated by sending and receiving organizations to assess the outcome of the secondment (strengths/weakness). Based on this evaluation, the recommendations on changes or improvements will be defined for implementation in future secondments. Along with the transfer of technical knowledge, **cultural and organizational factors** will be considered. These factors include language, work culture, and specifics of institutional structure. These are crucial considerations that may affect the performance of the person involved in the secondment. The host institution will develop mechanisms that introduce newcomers and help them to adapt to new environments effectively.

To make secondments and joint efforts to achieve common objectives most effective, it is of great importance to maintain communication and define clear and realistic expectations. This applies to the purpose, duration, objectives, and outcomes of the secondment as all of the partners must understand their roles and responsibilities to allocate appropriate resources.

By following the abovementioned statements, secondments will effectively facilitate knowledge sharing, ensure the transfer of expertise and lead to the development of sustainable collaboration within the mobility project.

Knowledge transfer is especially important and has a significant impact on **doctoral students and post-doctoral** researchers.

Describe the contribution of the action to the improvement of the research and innovation potential within Europe and/or worldwide

The proposed project is entirely based on collaborations via staff mobility activities on different levels (institutions, researchers, experts) across borders and disciplines. It will boost innovation at each organization by exposing project participants to new experiences (knowledge, expertise, environment). This inevitably will lift collective research and innovation capacity of the consortium consisting of institutions across the EU. Since mobility projects create opportunities to collaborate with leading experts and institutions across Europe, they may attract young talented researchers within the EU scientific community.

One of the main objectives of the project is a flow of knowledge, technologies, and research findings between academia, industry, and society. This implies communication among researchers, industrial partners, entrepreneurs, and policymakers to facilitate a move from purely scientific results to innovative solutions and products that are demanded by industries and society in order to stimulate economic growth. This will motivate researchers to move closer towards entrepreneurship and innovation, making the EU more competitive.

The intended collaborations will make it easier for the participants of the consortium to access external expertise and use infrastructure at partner institutions. Thus, the collective capacity of the consortium will be increased with the resulting ability to work on larger and more challenging tasks. In the long run, this is complementary to the global objective to maintain the EU as a global leader for research and innovation and create a gravity centre for funding, investments, and talents.

These ambitious objectives require equal opportunities for all achieved by promoting diversity. Only such an approach can unlock the full potential of human resources in the EU to set up a truly creative research community.

From a human capital perspective, the abovementioned factors (international collaboration, knowledge exchange and transfer, development of skills, attraction of talents and diversity) are the driving force that will ensure **economic and social progress** as well as **sustainable development**.

The described benefits from the mobility project are in line with the EU ambitions to create a borderless market for research, innovation and technology across Europe. The aim is to boost the **EU competitiveness** in research by achieving a "common market" for research and innovation. This implies enhanced multi-national collaboration with access to the labour market for researchers, state-of-the-art doctoral education and open opportunities for research careers.

If successful, the project has an opportunity to provide, in the long term, an excellent contribution to the improvement of the research and innovation potential and to society as a whole. The links built within the project between academic and industrial partners will strengthen the scientific potential of the research programme and implementation of the multifunctional materials developed under the project. The education and training of the fellows to become **highly skilled researchers** in the field of innovative composite materials will definitely contribute to the strengthening of Europe's human capital base in R&I and Europe's competitiveness, growth and attractiveness as a leading research destination hosting talented researchers and high-tech entrepreneurs.

The focus on the **Triple-I** dimension (international, inter-sectoral, and interdisciplinary research) will be maintained. **The international** aspect will be covered by the collaboration of academic and industrial partners from six EU countries (Czech Republic, Italy, Latvia, Lithuania, Slovakia, Sweden). **Inter-sectoral** and **interdisciplinary** aspects will be based on inter-complementarity (theoretical, applied and industrial) of the scientific competencies of the consortium building full-cycle research: non-aggressive synthesis of novel MXene nanoparticles, theoretically modelling the multifunctional behaviour of FRPC with MXene-based layers, testing and validation of multifunctional properties and up-scaling and demonstrating the developed innovative product.

The European Green Deal targets to achieve sustainability of the EU's economy through innovation and sustainable growth. It promotes clean energy and focuses on the reduction of greenhouse gas emissions. These are all objectives where the development of strong, damage-tolerant, lightweight, and reliable materials for use in severe service conditions can play an essential role since industries that are crucial for the economy and with impact on the environment (e.g. aeronautics, wind turbine, marine, automotive, commercial transport, etc.) will benefit the most from such innovations. The new materials developed within MIRACLES will allow lighter, stronger, more durable composite structures compared to currently used materials; thus, through weight reduction, it will contribute to energy efficiency and lower carbon emissions. More durable materials will extend the service life of structures, which will potentially reduce waste as well as allow re-use of materials after the end-of-life of the products. This will lower environmental impact and promote more efficient use of resources. Thus, it may be stated that project MIRACLES aims to create new solutions and trained professionals for future technological development, which is directly related to combat climate change and its impacts on environment. It is anticipated that the results of project MIRACLES will contribute to move towards sustainability, increase energy efficiency, and create innovative solutions within number of industries, which is in-line with the objectives of the European Green Deal.

The project is similarly well aligned with the EU missions under Horizon Europe, which targets climate change, sustainability and resource efficiency by providing support for research, innovation. The results of MIRACLES will be the development of advanced, more sustainable (e.g. longer service life, reusable) technologies and materials, thus providing industries with solutions to reduce the carbon footprint, which is within the objectives of EU missions focused on climate change mitigation. Not to mention reduction of resource consumption and waste generation by enhancing the product lifecycle.

The intended project type (Staff Exchanges) and content of the MIRACLES consortium will inevitably result in collaborations across different sectors and disciplines, which, in fact, is one of the main objectives of the project. To achieve the best results (technical but also economical and societal), the partnership of MIRACLES will have to engage in interdisciplinary research and collaboration between scientists, industries, and possibly policymakers. This is exactly the type of interaction that is promoted by Horizon Europe missions, as it will allow more efficient use of available resources, address more complex challenges, and achieve more significant changes.

The development of new materials and technologies within MIRACLES, as well as collaborations across different sectors and disciplines, will contribute to a number of UN Sustainable Development Goals (SDGs). The technological advancement in composite materials and processes anticipated in MIRACLES research will result in industrial growth, innovation, and enhanced infrastructure, thus benefiting SDG #9 "*Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*". It will also reduce the use of materials and production of waste as materials will be more durable and structures will require less maintenance, but at the same time, service life will be increased, thus complementing SDG #12 "*Ensure sustainable consumption and production patterns*". These new materials will allow more efficient production of clean, sustainable energy and reduction of pollution (due to weight reduction in transportation); thus, SDG #7 "*Ensure access to affordable, reliable, sustainable and modern energy for all*" and SDG #11 "*Make cities and human settlements inclusive, safe, resilient and sustainable*" will benefit. The commercialization of innovative technologies/materials will assist in creating high-tech production sites, making industries within the EU more competitive and creating new jobs; this, of course, will promote growth to benefit SDG #8 "*Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*". The MIRACLES is a staff exchange project which intends to build strong collaboration across different sectors and disciplines, facilitate knowledge transfer and provide training to researchers in academia as well as industrial partners, which is directly related to SDG #17 "*Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development*" and SDG #4 "*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*". The MIRACLES consortium will promote gender and diversity aspects to create an inclusive and equitable research environment, thus working towards SDG #5 "*Achieve gender equality and empower all women and girls*". The abovementioned goals and achievements will ultimately work towards combating climate change, therefore complementing to SDG #13 "*Take urgent action to combat climate change and its impacts*".

Figure 2.1. SDG pyramid for MIRACLES project.

Of course, some of the SDGs will be benefiting directly from the results of MIRACLES, while others will be only indirectly affected. To demonstrate the priority of the listed SDGs, the pyramid is presented in Fig. 2.1 (the top of the pyramid signifies primary SDGs that are directly addressed).

2.2. Credibility of the measures to enhance the career perspectives of staff members and contribution to their skills development

Describe how the action contributes to realising the potential of individuals

One of the specific objectives of the project is to enhance the scientific competences of the consortium staff mmbers and improve their career prospects. The career development programme will be based on several priorities.

Accumulation of new knowledge and skills by establishing new breakthroughs in the research of the multifunctional properties of FRPC with MXene-based layers. The added multifunctionality, effectiveness and applicability of the new composites developed under the project will be testified by using demonstrators. Then, the cumulative impact of the research activities can be foreseen as improved life-cycle of the composite materials, which in turn contributes positively to the decrease of plastic waste due to postponed need for repair or replacement of the composite component or structure. Lastly, as a consequence of all the benefits mentioned before, the appearance of new products can be expected. Inter-academia collaboration will promote interdisciplinary knowledge exchange, fortify the overall impact of the project, and establish a network of experts with diverse skills.

Focus on the "Triple-I" concept. The project will focus on international, inter-sectoral, and interdisciplinary research, providing an opportunity for researchers from KTU, LU, PISAS, VSCHT, LTU, and CNR researches to produce **high-quality** scientific **articles** based on their contributions to the project, encompassing novel findings in MXene utilisation. Industrial partners SYNPO, STIDO, COMEC, and SA will contribute to articles by sharing practical experiences.

Mobility within the project will allow academic staff to acquaint themselves with the international research context, learn from different scientific cultures, share experiences with international colleagues, and broaden their knowledge. Involvement in the project industrial organisations will provide their staff opportunities to collaborate with both industrial organizations and the academic community, gaining practical skills related to MXene production, characterization new materials, and application of these materials for industrial purposes.

Profile enhancement. Collaboration within the consortium and across academia will facilitate networking among researchers, **raising the profile of staff** by fostering connections with professionals in different fields, and creating potential for future collaborations. Secondments between academic and industrial partners will not only ensure the smooth execution of tasks and networking opportunities, but will also elevate the profile of academic staff in the industrial sector, opening up **new career opportunities**. Scientific publications and conference presentations will also contribute to raising the academic profile of the staff.

Maximising the benefits for staff. The international, inter-sectoral, and interdisciplinary nature of collaboration will allow industry and academia to see the wider impact of their research. This will enable academic staff to understand the practical applications and industry requirements of their work, fostering a more comprehensive and impactful research approach. Collaboration in the project will also promote the career development of staff by making them more versatile and adaptable researchers. The visibility gained through collaboration will enhance their professional reputation and open up opportunities for further professional development.

Raising the profile of the staff will be achieved through effective communication activities, including articles in local news portals, the MIRACLES website, and social media. Publicising the achievements of the project will enhance the visibility of the staff among the media and the general public. The staff of industrial partners, participating in demonstrating activities of the multifunctional properties of MXene layers in FRPC, will have the opportunity to introduce the practical application of scientific research to a broader audience, including industry stakeholders.

By exploring cleaner technologies for the production of structural FRPC, the project contributes to the EU's emphasis on sustainability and environmental responsibility. This **aligns with the EU's priorities** for advancing environmentally friendly materials and technologies. The emphasis of the project on the development of new materials and theoretical modelling reflects the commitment of the EU to "Industry 4.0". It supports the integration of digital technologies and smart manufacturing processes.

The MIRACLES project will contribute to the development of researchers by engaging them in the innovative task of developing cleaner technologies for the production of structural FRPC. This aligns with the goal of improving the **career competitiveness** of European researchers. The exploration of MXene-based layers in FRPC will involve interdisciplinary collaboration and practical experience, supporting the development of a wide range of skills. This is in line with the EU aim to provide **equal playing fields for researchers** of all backgrounds. The use of theoretical modelling reflects a commitment to advanced research techniques that improves the expertise of researchers. This aligns with the EU objective of **improving the competitiveness of European research careers** by fostering excellence in research and innovation.

2.3. Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including communication activities

Plan for the dissemination and exploitation activities, including communication activities

Dissemination, exploitation, and communication activities are of the major importance to maximize MIRACLES impact and trigger effects across the target audience. The final plan for the dissemination and exploitation, including communication activities, will be worked out, discussed and approved at the beginning of the project within WP6, taking into account actions of the consortium as a whole and particular partner, specific issues which different groups of stakeholders will receive in different ways according to the appropriate time plan. The plan will be updated regularly to reflect appropriate activities during the lifetime of the project. Still, the objectives will remain valid, and the consortium will be responsible for implementing them. These dissemination activities will take place in accordance with the MIRACLES CA. The first version of this plan is presented in Table 2.1.

Table 2.1 –Primary plan for dissemination, exploitation, and communication activities

	Activity	Target audience	When	Where	KPI
Dissemination	Articles in WoS Q1-Q3 scientific journals (e.g., Coatings, Composites Science and Technology, Materials, Materials and Structures, Small Methods, Nanoscale, etc.)	peers in the research field, industry	M6-M48	around the world	at least 12 articles
	Presentations in international world well-known conferences like European Conference on Composite Materials (ECCM), International Conference on Composite Materials (ICCM), MXene conference series, MRS meetings, etc.	peers in the research field, industry, commercial players, policy makers	M6-M48	around the world	at least 14 presentations; number of attendees at one conference 200-2000

	Disseminating research results at prominent industrial exhibitions, such as the renowned Hannover Messe and the JEC Composite Show	industry	M13-M48	around the world	100 flayers presenting the most promising project results
Exploitation	Develop research on the application of MXenes in structural composites or other applications	researchers	M34-M48 and after end of project	-	1 new topic for MXene application
	New research proposals with MIRACLES partners	researchers, industry			2 proposals for international calls
	MXene-based ink as a product based on the developed MXene formulations	industry			1 product
Communication	Articles in local news portals to show the impact of the MIRACLES research on citizens' daily lives	citizens, researchers, industry, commercial players, policy makers	M13-M48	Internet	2 articles
	MIRACLES webpage		M1-after end of project		1 webpage, 30 posts
	Social media, like LinkedIn, ResearchGate, and Facebook to inform on project results				20-40 posts
Public engagement	Citizen science activities or events (e. g. MSCA-Science is Wonderful, European Researchers' Night, local events e.g., Erdvelaivis Zeme or Technorama in Lithuania, etc.)	citizens, industry, commercial players, policy makers	M1-M48	organi-ser premise	4-6 events
	Visits to schools, hosting pupils in university or company facilities and laboratories, spreading popular science in the topic of MIRACLES by conducting lessons for pupils and involving them in practical activities.	school pupils, teachers		schools, univer-sities, compa-nies	2-4 activities

The plan is ambitious; hence, it may encounter challenges limiting achieving objectives. To maximise the effectiveness of the measures, partners will consult with their institution's specialists responsible for communication, relations, or marketing.

To assess whether dissemination, exploitation, and communication strategies are effective, their quality and success will be monitored by considering the citations of publications, attendance at events, engagement on social media platforms, comments on popular media articles, etc.

Strategy for the management of intellectual property, foreseen protection measures

Intellectual property rights (IPR) are key to building up and keeping trust in the project teams and also for building up the right attitudes; therefore, before performing joint scientific research with partners, the provisions on intellectual property management, its use and possession will be set in the MIRACLES Consortium Agreement (CA) between the parties. The consortium parties agree that Access Rights will only apply to relevant Background Information created by a research team directly involved in the project on behalf of the respective party, in accordance with the rules set out in the CA. During the project, the IPR management will be designed to guarantee identification, assessment, protection and subsequent exploitation. Once the results have been identified, the structured assessment process will be applied, including a thorough patent search, to determine whether or not the issue is best exploited via protection or through other means. Finally, if necessary, license agreements with third parties will be prepared where this is deemed necessary to maximise exploitation.

IPR will be ensured as provided in the contract to be awarded under the DESCA (or similar) model. It will be based on actions described in the CA and obligations related to background and results, and all items of knowledge relating to the work will be maintained throughout the project.

CA will cover issues related to ownership, legal protection, exploitation, dissemination of project results, ownership transfers, and IPR exploitation, which remain in force after the project's finish. Possible forms of IPR protection could be co-publication in journals and conference presentations of results developed using the MIRACLES, in which Copyright belongs to all contributors. The second possible form of protection is a Patent. A detailed definition of IPR object in the MIRACLES project will be done at the beginning of the project. All information flow exchanged between partners throughout the all-time of the project will be confidential, except information defined as "non-confidential".

IPR was planned and agreed upon before the consortium started the inter-organisational teamwork. Currently, partners have a general agreement on:

- Partners are not eligible for the prior knowledge, technologies and knowhow of partners;

- If necessary, the partners are ready to conclude a non-disclosure agreement about knowledge shared before the project, which is especially critical for partners working in the same field;

- All partners contributing to a specific result obtained during the project are considered co-authors and have equal rights independent of their financial and intellectual contribution.

2.4. The magnitude and importance of the project's contribution to the expected scientific, societal and economic impacts

The expected scientific, economic, technological, and societal impacts of the technologies developed within MIRACLES are summarised in Tables 2.1-2.3. The expected impacts are sorted as having **short-term (s)** (at the end of the project), **medium-term (m)** (less than five years after the project), and **long-term (l)** (more than five years after the project) **effects**. The expected technological developments of MIRACLES will have TRL 6 (technology demonstrated in a relevant environment). After the successful demonstration of the technology in the relevant environment based on the design and manufacturing of the three demonstrators, able to show the multifunctionality of FRPC with novel MXene-based layers, the transition to TRL 7 (system prototype demonstration in operational environment) beyond the project end will be foreseen. The plan for the transition to higher TRL beyond the project end includes the continuation of the collaboration between the consortium members and potential end-users, focusing on maximum exposure to industry and submitting joint research projects that contribute to the increase of innovation potential of this research.

Expected scientific impact

Table 2.1 - MIRACLES performance indicators for the scientific impacts

Expected impact	MIRACLES performance indicators	Target group
Creating high-quality knowledge	**(s) Knowledge expansion** through newly developed technology for preparing FRPC with MXene-based layers. **(s) 12 publications** in Q1-Q3 WoS journals and 14 presentations at world-known international scientific conferences.	-Wind energy sector -Aerospace sector -Automotive sector -Academic sector
Fostering diffusion of knowledge and open-source	**(s)** Popular scientific releases and publications on different social media for the profiles of the project and project participants. **(s)** All 12 publications will have open access. Horizon Europe mandatory and recommended open science principles will be followed.	-Academic sector -General public -Policymakers
Strengthening human capital in research and innovation	**(s)** Extended network of 10 partners from 6 countries and **improved inter-sectoral** and **interdisciplinary** opportunities due to broad international exposure. **(m)** Enhanced networking and communication with the general public by organizing/participating in public engagement events. **(l) Cutting-edge science** and more than 30 highly experienced researchers able to implement innovative products into industrial applications.	-Academic sector -Aerospace sector -Chemical sector -General public

Expected economic and technological impact

Table 2.2 - MIRACLES performance indicators for the economic and technological impacts

Expected impact	MIRACLES performance indicators	Target group
Generating innovation-based growth	**(s)** The newly developed **circular synthesis technology** will enable the reuse of chemical compounds and increase economic efficiency. **(l)** A highly sensitive piezoresistive MXene-based layer for the **health monitoring** of FRPC structures will enhance sensing efficiency, as it offers complete area coverage and biaxial strain sensing capabilities. **(l)** Localised **damage sensing** and real-time tracking of surface crack growth on composites will also become more efficient for the same reason.	-General public -Chemical sector -Aerospace sector -Wind energy sector -Automotive sector

	(l) The **weight of FRPC** will be reduced by more than tenfold compared to traditional carbon fibre-based de-icing systems, significantly lowering operational costs. **(l)** Improved **barrier properties** and durability by reduced water absorption rate up to 3 times are expected to extend the lifetime of FRPC structures by approximately three years and reduce life cycle costs. **(l)** Up to 30% reduction in **energy consumption** compared to existing de-icing systems, and the innovative ability to track ice formation and perform localised heating for curing.	
Creating more and better jobs	**(m) Improved employability** and career prospects within and outside academia due to increased research and transferable skills and competencies in high-tech and innovative R&D. **(l) Workplace improvement due to** simplified and more eco-friendly synthesis of MXenes.	-Policymakers -General public -Chemical sector
Leveraging investment in research and innovation	**(m) Expanded knowledge** in the research of the innovative material MXene, which is more environmentally friendly compared to other carbon-based nanoparticles. **(l) Boosted research and innovation capacity** in the EU due to developed networking between project partners, leading to the submission and implementation of joint project proposals during and after the end of the MIRACLES.	-Academic sector -Policymakers -Chemical sector -Aerospace sector -Wind energy sector -Automotive sector

Expected societal impact

Table 2.3 - MIRACLES performance indicators for the societal impacts

Expected impact	MIRACLES performance indicators	Target group
Addressing EU policy priorities and global challenges through research and innovation	**(s)** Development of **new eco-friendly** products since MXene is an environmentally friendly material developed by non-aggressive chemical methods. **(l) Enhanced sustainability** of future FRPC structures with improved protection from various environmental influences and **additional functionalities.**	-General public -Policymakers
Delivering benefits and impact through research and innovation missions	**(l)** Enabling longer and safer use of the materials for future applications of the proposed demonstrators, leading to **service life prolongation** and **energy savings** that will be beneficial for the environment.	-General public -Policymakers
Strengthening the uptake of research and innovation in society	**(m)** Positive contributions to **workers' health and safety are assumed** because no hazardous materials and compounds will be used.	-General public -Chemical sector -Aerospace sector -Wind energy sector -Automotive sector

The exposure to industry under MIRACLES will be ensured by establishing links between six consortium academic partners with four industrial partners. By introducing industrial partners, the production of binder-free MXene and MXene-polymer composite materials will be optimized (task leader -SYNPO), and three demonstrators will be developed: 1) for Joule heating applications (task leader -STIDO), 2) for sensing applications (task leader - COMEC), and 3) the demonstrator of improved barrier properties (task leader – SA). The cooperation with manufacturers focused on developing advanced products will minimize the gap between academia and industry, contributing to a higher impact of R&I output at the European level. Thus, the project will provide an excellent contribution to improving the research and innovation potential in the long term. It will be realized by up-scaling novel technologies for "close-to-industrial" production of MXenes with controlled surface functionalisation and MXene-polymer composite coating materials.

3. Quality and Efficiency of the Implementation

3.1. Quality and effectiveness of the work plan, assessment of risks and appropriateness of the effort assigned to work packages

Work Packages description

The MIRACLES work plan is organised into seven work packages; four are on research (WPs 1-4), WP5 deals with knowledge transfer, WP6 with communication, exploitation, and dissemination, and WP7 is aimed at project management. MIRACLES Pert Chart of research WPs is presented in Figure 3.1.

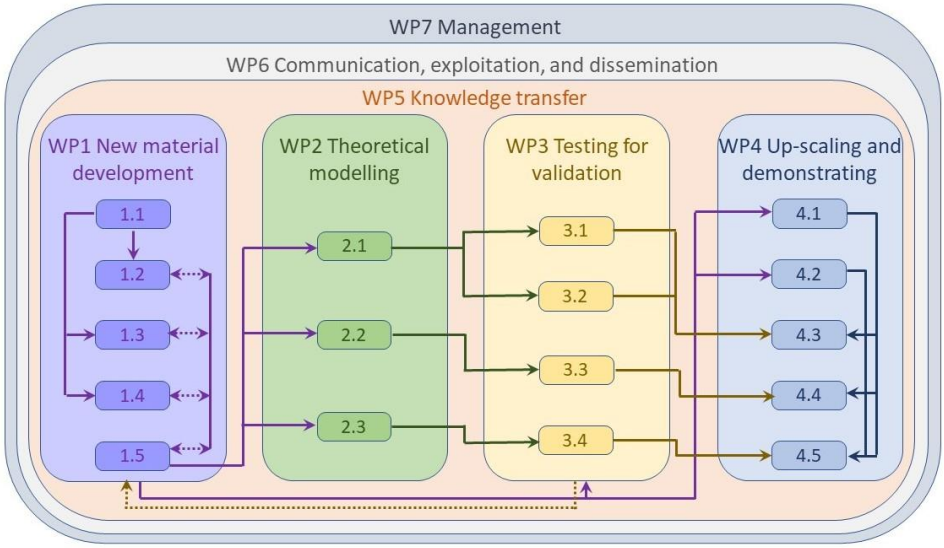

Figure 3.1. MIRACLES Pert chart.

3.2. Quality, capacity and role of each participant, including hosting arrangements and extent to which the consortium as a whole brings together the necessary expertise

Appropriateness of the research infrastructure and capacity of each participating organisation

The consortium partners possess the cutting-edge scientific research infrastructure necessary to achieve the project's objectives, as evident from the information provided in Section 4. The research facilities of all partners are fully independent and owned by the organisations and will be available for use by incoming secondees.

Six out of the ten consortium partners (KTU, LU, PISAS, LTU, SYNPO, SA) have experience in conducting MSCA SE projects. Sharing best practices will be straightforward with the remaining four partners, for whom participation in SE project activities will be a first. All partners are committed to being excellent hosts for visiting secondees. Should there be individuals among the visiting secondees facing such as mobility or similar issues, the host institutions are prepared for such challenges. This is demonstrated by the fact that all consortium academic organisations are EURAXESS Contact Points. Additionally, KTU, LTU, PISAS, CNR, and VSCHT have endorsed the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers (Charter & Code). Furthermore, KTU, LTU, PISAS, and VSCHT have received the HR Excellence in Research award.

Consortium composition and exploitation of participating organisations' complementarities

The MIRACLES consortium consists of six academic and four industrial partners. The secondments are well-thought-out, involving both experienced researchers, doctoral candidates, and post-doctoral researchers and technical staff.

All academic partners have substantial expertise in open science practices, including publishing in open-access journals, sharing data on open platforms, and participating in open peer review and collaborative research initiatives. Open science is an integral part of this project, which will follow EU open science policy of FAIR and the open access policies of the European Commission. The consortium is committed to fulfilling all OA requirements for the implementation of this project.

A streamlined management structure and balanced management procedures will facilitate the coherent and effective execution of the work plan. The Project Coordinator (PC) will be KTU team led by Prof. D. Zeleniakiene and they will be the main contact with the EC. KTU will carry out administrative tasks related to distribution of funding from the EC, reporting and other communication between the project and EC. The PC will be responsible to set up the General Assembly meetings and collect all materials for administrative reports. The General Assembly (GA) will be

the ultimate decision-making body of the consortium. The GA will meet every 12 months and will consist of a representative from each partner with authority to commit the corresponding organisation to decisions taken by the assembly. Each partner will have one vote in the GA. The Executive Board (EB) will consist of WP leaders which will be responsible for coordinating, monitoring and reporting of the corresponding WP, presenting deliverables according to plans, informing the PC about deviation from plans and implementing any necessary actions. The EB will meet on regular online meetings to monitor the progress between the physical meetings.

The **communication strategy** within the consortium and external bodies is described in Sec. 2.3. The handling of **intellectual property** (IP) will be done as described in the CA, and both dissemination, exploitation, and communication strategies will be fully aligned in order to allow appropriate communication of project activities without jeopardising exploitation of the results. **Risks management** will be planned to avoid the risks that may emerge during the implementation of the project. The GA will identify risks at the consortium level to ensure that the consortium successfully achieves its objectives. They will also identify appropriate contingency measures that will serve to ensure that the technical work continues without critical problems.

The consortium partners are divided into three groups. Group I, represented by academic partners KTU, LU, and LTU, covers the field of engineering and possesses profound knowledge of materials and mechanical engineering. Group II, also consisting of academic partners represented by VSCHT, PISAS, and CNR, broadly covers the field of chemistry, with knowledge in both inorganic and organic chemistry. Group III comprises industrial partners SYNPO, STIDO, COMEC, and SA, whose main strengths lie in the applicability of innovations to production according to market needs. All three groups participate proportionally in the development of new materials (WP1, Groups I and II), theoretical modelling (WP2, Groups I and II), testing for validation (WP3, all groups), and up-scaling and demonstration (WP4, all groups), thereby complementing each other and creating significant synergy essential for achieving the objectives.

4. Ethics

4.1. Ethics self-assessment

Ethical dimension of the objectives, methodology and likely impact

In this project, there are no tasks raising ethics issues.

Objectives of the Activities: The project does not involve studying vulnerable populations or any other group that could raise ethical concerns related to exploitation or consent.

Methodology: The project does not include clinical trials, involvement of children, or the collection of personal data, thus avoiding ethical concerns associated with these methodologies.

Potential Impact of the Activities: There are no expected negative impacts such as environmental damage, stigmatization of social groups, or political and financial adverse consequences.

4.2. Compliance with ethical principles and relevant legislations

MIRACLES will be managed in compliance with ethical principles and applicable international, EU and national law in the implementation of research and innovation activities. Any ethical concerns raised by those activities will be handled following rigorously the recommendations provided in the European Commission Ethics Self-Assessment Guidelines.

4.3. Ethics issues

For MIRACLES there are no additional ethics requirements. The Ethics opinion is “cleared”.

5. Participating organizations

Table 5.1– Data for non-academic beneficiaries

Name	Location of research premises (city/country)	Type of R&I activities	No. of full - time employees involved in the project	No. of employees in R&I	Web site	Annual turnover (approx. in Euro)
SYNPO	Pardubice/ Czech Republic	Organic type of coatings (alkyds, polyesters, polyurethan es, epoxies and acrylates), composites, casting	9	75	www.synpo.cz/en	7.304 M€

		compounds, adhesives, laminating resins				
STIDO	Taurai/ Lithuania	Design, materials engineering, mechanical engineering, manufacturing of fibre reinforced plastic composites for transport industry	5	3	www.stido.lt/	1.7 M€
COMEC	Chieti/Italy	Production of machines for the impregnation and deposition of composite materials, innovation in composite material products, structural functionalization with sensors in additive manufacturing	4 (3 secondees)	5	www.comecinnovative.it	8-10 M€
SA	Pociunai/ Lithuania	Design, materials engineering, mechanical engineering, fibre reinforced plastic composites for aviation	5	3	www.lak.lt/	0.5-1 M€

ANNEX 2

ESTIMATED BUDGET FOR THE ACTION

	Estimated EU contribution					
	Estimated eligible unit contributions (per budget category)					
	A. Contributions for seconded staff members		B. Institutional contributions		Total	Maximum grant amount[1]
	A.1 Top - up allowance	A.5 Special needs allowance	B.1 Research, training and networking contribution	B.2 Management and indirect contribution		
Forms of funding	Unit contribution[2]	Unit contribution[2]	Unit contribution[2]	Unit contribution[2]	h = a + e + f + g	i
	a	e	f	g		
1 - KTU	96 600.00	0.00	54 600.00	42 000.00	193 200.00	193 200.00
2 - LU	92 000.00	0.00	52 000.00	40 000.00	184 000.00	184 000.00
3 - PISAS	57 500.00	0.00	32 500.00	25 000.00	115 000.00	115 000.00
4 - VSCHT	13 800.00	0.00	7 800.00	6 000.00	27 600.00	27 600.00
5 - CNR	57 500.00	0.00	32 500.00	25 000.00	115 000.00	115 000.00
6 - LTU	41 400.00	0.00	23 400.00	18 000.00	82 800.00	82 800.00
7 - SYNPO	20 700.00	0.00	11 700.00	9 000.00	41 400.00	41 400.00
8 - STIDO	46 000.00	0.00	26 000.00	20 000.00	92 000.00	92 000.00
9 - COMEC	23 000.00	0.00	13 000.00	10 000.00	46 000.00	46 000.00
10 - SA	23 000.00	0.00	13 000.00	10 000.00	46 000.00	46 000.00
Σ consortium	471 500.00	0.00	266 500.00	205 000.00	943 000.00	943 000.00

[1] The 'maximum grant amount' is the maximum grant amount fixed in the grant agreement (on the basis of the sum of the beneficiaries' estimated units).
[2] See Annex 2a 'Additional information on the estimated budget' for the details (units, amount per unit).

ANNEX 2a

ADDITIONAL INFORMATION ON UNIT COSTS AND CONTRIBUTIONS

HE MSCA Doctoral Networks/Post-doctoral Fellowships and HE ERA fellowships

See Additional information on unit costs and contributions (Annex 2a and 2b)

HE MSCA Staff Exchanges

See Additional information on unit costs and contributions (Annex 2a and 2b)

HE MSCA COFUND

See Additional information on unit costs and contributions (Annex 2a and 2b)

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

LATVIJAS UNIVERSITATE (LU), PIC 999871830, established in RAINA BOULEVARD 19, RIGA 1586, Latvia,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

Guntars KITENBERGS with ECAS id nkitengu signed in the Participant Portal on 07/08/2024 at 13:53:29 (transaction id SigId-79971-UJEjpO U6AWtZOLXjnLBehLc1RKOefPYXojlEwKRX51BaMYBIuzzc62HLkhxVyj SrZlwwO3JmzczJBmlVUpYDk0q-yntOf97TTHqAX5yfJ7HQNG-HPo0lQk FQmwRk3uHbkQX8X6NqPTROTFgF0ucRZzwBTjPfdJCYEwTPPjK8eHrG CpUUJzqZ6m95bhKANLPnyNMzZW). Timestamp by third party at 2024.08.07 13:53:36 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

USTAV POLYMEROV SLOVENSKEJ AKADEMIEVIED VEREJNA VYSKUMNA INSTITUCIA (PISAS), PIC 998528574, established in DUBRAVSKA CESTA 5798/9, BRATISLAVA 845 41, Slovakia,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

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SIGNATURE

For the beneficiary

Matej MICUSIK with ECAS id nmicusma signed in the Participant Portal on 06/08/2024 at 14:30:39 (transaction id SigId-69230-7sd4MQWN8LyX5FicFHRcSbogtOu0GHSotM88DUc9soG3rM99qle3flSkydOfzODm2yqiCnUk5Ofr2FwoOMdiMy-yntOf97TTHqAX5yfJ7HQNG-BQFWJsmAXBlZycNoGDU5DpSbWy9FqVD2qMLTrEJSqZtvMrARzoM47X8QL7VzIQjdcE5wU4Us4kRAKtX1Q3ezl7W). Timestamp by third party at 2024.08.06 14:30:45 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

VYSOKA SKOLA CHEMICKO-TECHNOLOGICKA V PRAZE (VSCHT), PIC 999867853, established in TECHNICKA 5, PRAHA 166 28, Czechia,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

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SIGNATURE

For the beneficiary

Pavel NOVAK with ECAS id nnovakpl signed in the Participant Portal on 06/08/2024 at 14:25:50 (transaction id SigId-69136-NXPt2eRzzK1zXkDy9N3cCjbtVVzesm06Tdiiw4Di74qzHEiwHC06mygWzaS4rf5awZEaLXf2vgowCaO9CK5ZQrLW-yntOf97TTHqAX5yfJ7HQNG-lzTXyDasFGvTE4uFt2W9h3IiD6l1hLubK1MYy4ujY3TGMSeUGkiizw3zIE2NIezWBQhAzN1c5t1XJWUCAPyV8JL). Timestamp by third party at 2024.08.06 14:25:55 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR), PIC 999979500, established in PIAZZALE ALDO MORO 7, ROMA 00185, Italy,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

By signing this accession form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and terms and conditions it sets out.

SIGNATURE

For the beneficiary

EUGENIO AMENDOLA with ECAS id nameneug signed in the Participant Portal on 06/08/2024 at 18:27:20 (transaction id SigId-72956-81r658ukx401KVmo5bo8Q7ae9oASXeFYyhCQ1v6wymzzac80C wKEoMZggGdRkpRazTsDgRt9CPyaeM4ZaVWfbSm-yntOf97TTHqAX5yfJ7HQNG-hxYWa8tQgQUDLqoIMUiTp1IKt7ZNA6jRlJ RzZvWXuIlRK91ZKOo6NDeCnkDftIBHZpWDVrKflDVDqwiChI8wZS). Timestamp by third party at 2024.08.06 18:27:26 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

LULEA TEKNISKA UNIVERSITET (LTU), PIC 999876874, established in UNIVERSITETSOMRADET PORSON, LULEA 971 87, Sweden,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

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SIGNATURE

For the beneficiary

Margareta Ring Groth with ECAS id n007kva1 signed in the Participant Portal on 23/08/2024 at 11:14:47 (transaction id SigId-3770-jFEzGszxUgR8oWc30nHs65irIPFGy4klGJcn4N7x8xvrYzzLLJGpb3lA6XQRzcdzIIdiXzlgOSEoxp78p8bxBfNC-jpJZscgsw0K3AqgQ9TY66G-ZO03X0rNMPzJpX8aCgWsIR0KrHaWSqNAiNEj2qVUDjBVzxrsu4dOwcf3U5lcr0GWMIPSuGzbFYPRR6FkcjJVrzi). Timestamp by third party at 2024.08.23 11:14:57 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

SYNPO AKCIOVA SPOLECNOST (SYNPO), PIC 988900063, established in S K NEUMANNA 1316 ZELENE PREDMESTI, PARDUBICE 532 07, Czechia,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

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SIGNATURE

For the beneficiary

Jan HYRŠL with ECAS id nhyrslja signed in the Participant Portal on 06/08/2024 at 14:13:44 (transaction id SigId-68913-GknmYhLkGm1oAKkK1JGL10DOxRR7PNy6eOfvXtzZEORuthNJv9tQda3dgSMAr5sWgt9aW9zmAvFIsQ77jeGgzIm-yntOf97TTHqAX5yfJ7HQNG-gkBihUlvZDoKsKMup64MwiezyIbh7Puqg6KmupX3AzQjiDWeTZIq6UeeC7YFVcc69FwMF9XXvl9IyFzlC9vHNYW). Timestamp by third party at 2024.08.06 14:13:49 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UAB STIDO (STIDO), PIC 879736069, established in VERSLININKU G. 23, TAURU K., TAURAGES R. LT-72116, Lithuania,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

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SIGNATURE

For the beneficiary

Andrius Ivascenko with ECAS id n00gj42u signed in the Participant Portal on 07/08/2024 at 07:03:00 (transaction id SigId-73942-RoPPzG Mylr2yNqWCTzHa7SNPVQa3NYJnvF1zjy9F8pyVgtK7wI0KeSgaDm57t 6iEwbBwqzotCB7KMOCyTM4iqrO-yntOf97TTHqAX5yfJ7HQNG-HSGyJ mAWsuBkQeiczPakibe1mLHE4KsrW97aDGUzroxzRzmberAu3tqi6bok M8M7FUJlhHp1myNCgzVXrlPudaA). Timestamp by third party at 2024.08.07 07:03:08 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

COMEC - COSTRUZIONI MECCANICHE INNOVATIVE SRL (COMEC), PIC 950066695, established in VIALE ABRUZZO 330, CHIETI CH 66013, Italy,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

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SIGNATURE

For the beneficiary

Giulio Trevisan with ECAS id n00aznkz signed in the Participant Portal on 06/08/2024 at 15:16:40 (transaction id SigId-70160-S8ycV PfEk2lTvKxpcQjPyw3NTIhNCTqaNq9Rd0BtmGkTItsrpTwvzRqJYgW3 cQwYrODKoo787F2zJOrwc7Lsix-yntOf97TTHqAX5yfJ7HQNG-bmXq ALOYL5pme3l4nnJtWFfCJ06YirQzeAGq5kzRPHUVlXH3uw05zxb8XP PzzjI0VCzTYzX4xszPLZRzd1G4lVAA0). Timestamp by third party at 2024.08.06 15:16:45 CEST

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UAB SPORTINE AVIACIJA IR KO (SA), PIC 918723182, established in DEBESU STR. 16 POCIUNU K., PRIENU R., PRIENAI 59327, Lithuania,

hereby agrees

to become beneficiary

in Agreement No 101182521 — MIRACLES ('the Agreement')

between KAUNO TECHNOLOGIJOS UNIVERSITETAS (KTU) **and** the **European Research Executive Agency (REA)** ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 39.

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SIGNATURE

For the beneficiary

Vytautas Mačiulis with ECAS id n00cge3e signed in the Participant Portal on 20/08/2024 at 10:21:32 (transaction id SigId-45602-7X28p15QdtwvrxNZoabqit1Dq59bJ1OL47aSLbjwgqQHzKuuS7yWiE0sHVI48xDfzZA9jDevhUVmJiHLdKO4Xa-rS0vSrmBGYCwK7zjY6UeIG-smmzTXzGtio21to5k2ATC4BszbrS3Vihdjazp8wvofmRnIYzMN5zUMEzr8zeOIikmeiGkAaiNnDlfanmhVMFlpxW). Timestamp by third party at 2024.08.20 10:21:38 CEST

FINANCIAL STATEMENT FOR [PARTICIPANT NAME] FOR REPORTING PERIOD [NUMBER]

	EU contribution								
	Eligible unit contributions (per budget category)								**Requested EU contribution**
	[OPTION for all MSCA ToA except COFUND: **A. . Contributions for** *[* **recruited researchers***]* *[* **seconded staff members***]][OPTION for COFUND:* **A. COFUND contributions***]*					*[OPTION for all MSCA ToA except COFUND:* **B. Institutional contributions***]*		**Total**	
	[OPTION for DN and PF : A.1 Living allowance*]* *[OPTION for SE:* A.1 Top - up allowance*]* *[OPTION for COFUND:* A.1 COFUND allowance*]*	*[OPTION for DN and PF:* A.2 Mobility allowance*]*	*[OPTION for DN and PF:* A.3 Family allowance*]*	*[OPTION for all MSCA ToA except SE:* A.4 Long-term leave allowance*]*	A.5 Special needs allowance	*[* B.1 Research, training and networking contribution*]*	*[* B.2 Management and indirect contribution*]*		
Forms of funding	Unit contribution[1]	*[* Unit contribution[1] *]*	*[* Unit contribution[1] *]*	*[* Unit contribution[1] *]*	Unit contribution[1]	*[* Unit contribution[1] *]*	*[* Unit contribution[1] *]*	h = a *[* + b *][* + c*]* *[* + d*]* + e *[* + f*]* *[* + g*]*	i
	a	*[* b*]*	*[* c*]*	*[* d*]*	e	*[* f*]*	*[* g*]*		
XX – [short name beneficiary/affiliated entity]									

The beneficiary/affiliated entity hereby confirms that:

The information provided is complete, reliable and true.

The unit contributions declared are eligible (see Article 6).

The contributions can be substantiated by adequate records and supporting documentation that will be produced upon request or in the context of checks, reviews, audits and investigations (see Articles 19, 20 and 25).

[1] See Annex 2a 'Additional information on the estimated budget' for the details (units, amount per unit).

ANNEX 5

SPECIFIC RULES

CONFIDENTIALITY AND SECURITY (— ARTICLE 13)

Sensitive information with security recommendation

Sensitive information with a security recommendation must comply with the additional requirements imposed by the granting authority.

Before starting the action tasks concerned, the beneficiaries must have obtained all approvals or other mandatory documents needed for implementing the task. The documents must be kept on file and be submitted upon request by the coordinator to the granting authority. If they are not in English, they must be submitted together with an English summary.

For requirements restricting disclosure or dissemination, the information must be handled in accordance with the recommendation and may be disclosed or disseminated only after written approval from the granting authority.

EU classified information

If EU classified information is used or generated by the action, it must be treated in accordance with the security classification guide (SCG) and security aspect letter (SAL) set out in Annex 1 and Decision 2015/444[1] and its implementing rules — until it is declassified.

Deliverables which contain EU classified information must be submitted according to special procedures agreed with the granting authority.

Action tasks involving EU classified information may be subcontracted only with prior explicit written approval from the granting authority and only to entities established in an EU Member State or in a non-EU country with a security of information agreement with the EU (or an administrative arrangement with the Commission).

EU classified information may not be disclosed to any third party (including participants involved in the action implementation) without prior explicit written approval from the granting authority.

ETHICS (— ARTICLE 14)

Ethics and research integrity

The beneficiaries must carry out the action in compliance with:

- ethical principles (including the highest standards of research integrity)

[1] Commission Decision 2015/444/EC, Euratom of 13 March 2015 on the security rules for protecting EU classified information (OJ L 72, 17.3.2015, p. 53).

and

- applicable EU, international and national law, including the EU Charter of Fundamental Rights and the European Convention for the Protection of Human Rights and Fundamental Freedoms and its Supplementary Protocols.

No funding can be granted, within or outside the EU, for activities that are prohibited in all Member States. No funding can be granted in a Member State for an activity which is forbidden in that Member State.

The beneficiaries must pay particular attention to the principle of proportionality, the right to privacy, the right to the protection of personal data, the right to the physical and mental integrity of persons, the right to non-discrimination, the need to ensure protection of the environment and high levels of human health protection.

The beneficiaries must ensure that the activities under the action have an exclusive focus on civil applications.

The beneficiaries must ensure that the activities under the action do not:

- aim at human cloning for reproductive purposes
- intend to modify the genetic heritage of human beings which could make such modifications heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed)
- intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer, or
- lead to the destruction of human embryos (for example, for obtaining stem cells).

Activities involving research on human embryos or human embryonic stem cells may be carried out only if:

- they are set out in Annex 1 or
- the coordinator has obtained explicit approval (in writing) from the granting authority.

In addition, the beneficiaries must respect the fundamental principle of research integrity — as set out in the European Code of Conduct for Research Integrity[2].

This implies compliance with the following principles:

- reliability in ensuring the quality of research reflected in the design, the methodology, the analysis and the use of resources
- honesty in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair and unbiased way

[2] European Code of Conduct for Research Integrity of ALLEA (All European Academies).

- respect for colleagues, research participants, society, ecosystems, cultural heritage and the environment

- accountability for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts

and means that beneficiaries must ensure that persons carrying out research tasks follow the good research practices including ensuring, where possible, openness, reproducibility and traceability and refrain from the research integrity violations described in the Code.

Activities raising ethical issues must comply with the additional requirements formulated by the ethics panels (including after checks, reviews or audits; see Article 25).

Before starting an action task raising ethical issues, the beneficiaries must have obtained all approvals or other mandatory documents needed for implementing the task, notably from any (national or local) ethics committee or other bodies such as data protection authorities.

The documents must be kept on file and be submitted upon request by the coordinator to the granting authority. If they are not in English, they must be submitted together with an English summary, which shows that the documents cover the action tasks in question and includes the conclusions of the committee or authority concerned (if any).

VALUES (— ARTICLE 14)

Gender mainstreaming

The beneficiaries must take all measures to promote equal opportunities between men and women in the implementation of the action and, where applicable, in line with the gender equality plan. They must aim, to the extent possible, for a gender balance at all levels of personnel assigned to the action, including at supervisory and managerial level.

INTELLECTUAL PROPERTY RIGHTS (IPR) — BACKGROUND AND RESULTS — ACCESS RIGHTS AND RIGHTS OF USE (— ARTICLE 16)

Definitions

Access rights — Rights to use results or background.

Dissemination — The public disclosure of the results by appropriate means, other than resulting from protecting or exploiting the results, including by scientific publications in any medium.

Exploit(ation) — The use of results in further research and innovation activities other than those covered by the action concerned, including among other things, commercial exploitation such as developing, creating, manufacturing and marketing a product or process, creating and providing a service, or in standardisation activities.

Fair and reasonable conditions — Appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the results or background to which access is requested and/or the scope, duration or other characteristics of the exploitation envisaged.

FAIR principles — ‘findability’, ‘accessibility’, ‘interoperability’ and ‘reusability’.

Open access — Online access to research outputs provided free of charge to the end-user.

Open science — An approach to the scientific process based on open cooperative work, tools and diffusing knowledge.

Research data management — The process within the research lifecycle that includes the organisation, storage, preservation, security, quality assurance, allocation of persistent identifiers (PIDs) and rules and procedures for sharing of data including licensing.

Research outputs — Results to which access can be given in the form of scientific publications, data or other engineered results and processes such as software, algorithms, protocols, models, workflows and electronic notebooks.

Scope of the obligations

For this section, references to ‘beneficiary’ or ‘beneficiaries’ do not include affiliated entities (if any).

Agreement on background

The beneficiaries must identify in a written agreement the background as needed for implementing the action or for exploiting its results.

Where the call conditions restrict control due to strategic interests reasons, background that is subject to control or other restrictions by a country (or entity from a country) which is not one of the eligible countries or target countries set out in the call conditions and that impact the exploitation of the results (i.e. would make the exploitation of the results subject to control or restrictions) must not be used and must be explicitly excluded from it in the agreement on background — unless otherwise agreed with the granting authority.

Ownership of results

Results are owned by the beneficiaries that generate them.

However, two or more beneficiaries own results jointly if:

- they have jointly generated them and
- it is not possible to:
    - establish the respective contribution of each beneficiary, or
    - separate them for the purpose of applying for, obtaining or maintaining their protection.

The joint owners must agree — in writing — on the allocation and terms of exercise of their joint ownership (‘**joint ownership agreement**’), to ensure compliance with their obligations under this Agreement.

Unless otherwise agreed in the joint ownership agreement or consortium agreement, each joint owner may grant non-exclusive licences to third parties to exploit the jointly-owned results (without any right to sub-license), if the other joint owners are given:

- at least 45 days advance notice and
- fair and reasonable compensation.

The joint owners may agree — in writing — to apply another regime than joint ownership.

If third parties (including employees and other personnel) may claim rights to the results, the beneficiary concerned must ensure that those rights can be exercised in a manner compatible with its obligations under the Agreement.

The beneficiaries must indicate the owner(s) of the results (results ownership list) in the final periodic report.

Protection of results

Beneficiaries which have received funding under the grant must adequately protect their results — for an appropriate period and with appropriate territorial coverage — if protection is possible and justified, taking into account all relevant considerations, including the prospects for commercial exploitation, the legitimate interests of the other beneficiaries and any other legitimate interests.

Exploitation of results

Beneficiaries which have received funding under the grant must — up to four years after the end of the action (see Data Sheet, Point 1) — use their best efforts to exploit their results directly or to have them exploited indirectly by another entity, in particular through transfer or licensing.

If, despite a beneficiary's best efforts, the results are not exploited within one year after the end of the action, the beneficiaries must (unless otherwise agreed in writing with the granting authority) use the Horizon Results Platform to find interested parties to exploit the results.

If results are incorporated in a standard, the beneficiaries must (unless otherwise agreed with the granting authority or unless it is impossible) ask the standardisation body to include the funding statement (see Article 17) in (information related to) the standard.

Additional exploitation obligations

Where the call conditions impose additional exploitation obligations (including obligations linked to the restriction of participation or control due to strategic assets, interests, autonomy or security reasons), the beneficiaries must comply with them — up to four years after the end of the action (see Data Sheet, Point 1).

Where the call conditions impose additional exploitation obligations in case of a public emergency, the beneficiaries must (if requested by the granting authority) grant for a limited period of time specified in the request, non-exclusive licences — under fair and reasonable conditions — to their results to legal entities that need the results to address the public emergency and commit to rapidly and broadly exploit the resulting products and services at

fair and reasonable conditions. This provision applies up to four years after the end of the action (see Data Sheet, Point 1).

Additional information obligation relating to standards

Where the call conditions impose additional information obligations relating to possible standardisation, the beneficiaries must — up to four years after the end of the action (see Data Sheet, Point 1) — inform the granting authority, if the results could reasonably be expected to contribute to European or international standards.

Transfer and licensing of results

Transfer of ownership

The beneficiaries may transfer ownership of their results, provided this does not affect compliance with their obligations under the Agreement.

The beneficiaries must ensure that their obligations under the Agreement regarding their results are passed on to the new owner and that this new owner has the obligation to pass them on in any subsequent transfer.

Moreover, they must inform the other beneficiaries with access rights of the transfer at least 45 days in advance (or less if agreed in writing), unless agreed otherwise in writing for specifically identified third parties including affiliated entities or unless impossible under the applicable law. This notification must include sufficient information on the new owner to enable the beneficiaries concerned to assess the effects on their access rights. The beneficiaries may object within 30 days of receiving notification (or less if agreed in writing), if they can show that the transfer would adversely affect their access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned.

Granting licences

The beneficiaries may grant licences to their results (or otherwise give the right to exploit them), including on an exclusive basis, provided this does not affect compliance with their obligations.

Exclusive licences for results may be granted only if all the other beneficiaries concerned have waived their access rights.

Granting authority right to object to transfers or licensing — Horizon Europe actions

Where the call conditions in Horizon Europe actions provide for the right to object to transfers or licensing, the granting authority may — up to four years after the end of the action (see Data Sheet, Point 1) — object to a transfer of ownership or the exclusive licensing of results, if:

- the beneficiaries which generated the results have received funding under the grant
- it is to a legal entity established in a non-EU country not associated with Horizon Europe, and

- the granting authority considers that the transfer or licence is not in line with EU interests.

Beneficiaries that intend to transfer ownership or grant an exclusive licence must formally notify the granting authority before the intended transfer or licensing takes place and:

- identify the specific results concerned
- describe in detail the new owner or licensee and the planned or potential exploitation of the results, and
- include a reasoned assessment of the likely impact of the transfer or licence on EU interests, in particular regarding competitiveness as well as consistency with ethical principles and security considerations.

The granting authority may request additional information.

If the granting authority decides to object to a transfer or exclusive licence, it must formally notify the beneficiary concerned within 60 days of receiving notification (or any additional information it has requested).

No transfer or licensing may take place in the following cases:

- pending the granting authority decision, within the period set out above
- if the granting authority objects
- until the conditions are complied with, if the granting authority objection comes with conditions.

A beneficiary may formally notify a request to waive the right to object regarding intended transfers or grants to a specifically identified third party, if measures safeguarding EU interests are in place. If the granting authority agrees, it will formally notify the beneficiary concerned within 60 days of receiving notification (or any additional information requested).

Limitations to transfers and licensing due to strategic assets, interests, autonomy or security reasons of the EU and its Member States

Where the call conditions restrict participation or control due to strategic assets, interests, autonomy or security reasons, the beneficiaries may not transfer ownership of their results or grant licences to third parties which are established in countries which are not eligible countries or target countries set out in the call conditions (or, if applicable, are controlled by such countries or entities from such countries) — unless they have requested and received prior approval by the granting authority.

The request must:

- identify the specific results concerned
- describe in detail the new owner and the planned or potential exploitation of the results, and
- include a reasoned assessment of the likely impact of the transfer or license on the strategic assets, interests, autonomy or security of the EU and its Member States.

The granting authority may request additional information.

Access rights to results and background

Exercise of access rights — Waiving of access rights — No sub-licensing

Requests to exercise access rights and the waiver of access rights must be in writing.

Unless agreed otherwise in writing with the beneficiary granting access, access rights do not include the right to sub-license.

If a beneficiary is no longer involved in the action, this does not affect its obligations to grant access.

If a beneficiary defaults on its obligations, the beneficiaries may agree that that beneficiary no longer has access rights.

Access rights for implementing the action

The beneficiaries must grant each other access — on a royalty-free basis — to background needed to implement their own tasks under the action, unless the beneficiary that holds the background has — before acceding to the Agreement —:

- informed the other beneficiaries that access to its background is subject to restrictions, or
- agreed with the other beneficiaries that access would not be on a royalty-free basis.

The beneficiaries must grant each other access — on a royalty-free basis — to results needed for implementing their own tasks under the action.

Access rights for exploiting the results

The beneficiaries must grant each other access — under fair and reasonable conditions — to results needed for exploiting their results.

The beneficiaries must grant each other access — under fair and reasonable conditions — to background needed for exploiting their results, unless the beneficiary that holds the background has — before acceding to the Agreement — informed the other beneficiaries that access to its background is subject to restrictions.

Requests for access must be made — unless agreed otherwise in writing — up to one year after the end of the action (see Data Sheet, Point 1).

Access rights for entities under the same control

Unless agreed otherwise in writing by the beneficiaries, access to results and, subject to the restrictions referred to above (if any), background must also be granted — under fair and reasonable conditions — to entities that:

- are established in an EU Member State or Horizon Europe associated country
- are under the direct or indirect control of another beneficiary, or under the same direct or indirect control as that beneficiary, or directly or indirectly controlling that beneficiary and

- need the access to exploit the results of that beneficiary.

Unless agreed otherwise in writing, such requests for access must be made by the entity directly to the beneficiary concerned.

Requests for access must be made — unless agreed otherwise in writing — up to one year after the end of the action (see Data Sheet, Point 1).

Access rights for the granting authority, EU institutions, bodies, offices or agencies and national authorities to results for policy purposes — Horizon Europe actions

In Horizon Europe actions, the beneficiaries which have received funding under the grant must grant access to their results — on a royalty-free basis — to the granting authority, EU institutions, bodies, offices or agencies for developing, implementing and monitoring EU policies or programmes. Such access rights do not extend to beneficiaries' background.

Such access rights are limited to non-commercial and non-competitive use.

For actions under the cluster 'Civil Security for Society', such access rights also extend to national authorities of EU Member States for developing, implementing and monitoring their policies or programmes in this area. In this case, access is subject to a bilateral agreement to define specific conditions ensuring that:

- the access rights will be used only for the intended purpose and

- appropriate confidentiality obligations are in place.

Moreover, the requesting national authority or EU institution, body, office or agency (including the granting authority) must inform all other national authorities of such a request.

Additional access rights

Where the call conditions impose additional access rights, the beneficiaries must comply with them.

COMMUNICATION, DISSEMINATION, OPEN SCIENCE AND VISIBILITY (— ARTICLE 17)

Dissemination

Dissemination of results

The beneficiaries must disseminate their results as soon as feasible, in a publicly available format, subject to any restrictions due to the protection of intellectual property, security rules or legitimate interests.

A beneficiary that intends to disseminate its results must give at least 15 days advance notice to the other beneficiaries (unless agreed otherwise), together with sufficient information on the results it will disseminate.

Any other beneficiary may object within (unless agreed otherwise) 15 days of receiving notification, if it can show that its legitimate interests in relation to the results or background would be significantly harmed. In such cases, the results may not be disseminated unless appropriate steps are taken to safeguard those interests.

Additional dissemination obligations

Where the call conditions impose additional dissemination obligations, the beneficiaries must also comply with those.

Open Science

Open science: open access to scientific publications

The beneficiaries must ensure open access to peer-reviewed scientific publications relating to their results. In particular, they must ensure that:

- at the latest at the time of publication, a machine-readable electronic copy of the published version or the final peer-reviewed manuscript accepted for publication, is deposited in a trusted repository for scientific publications

- immediate open access is provided to the deposited publication via the repository, under the latest available version of the Creative Commons Attribution International Public Licence (CC BY) or a licence with equivalent rights; for monographs and other long-text formats, the licence may exclude commercial uses and derivative works (e.g. CC BY-NC, CC BY-ND) and

- information is given via the repository about any research output or any other tools and instruments needed to validate the conclusions of the scientific publication.

Beneficiaries (or authors) must retain sufficient intellectual property rights to comply with the open access requirements.

Metadata of deposited publications must be open under a Creative Common Public Domain Dedication (CC 0) or equivalent, in line with the FAIR principles (in particular machine-actionable) and provide information at least about the following: publication (author(s), title, date of publication, publication venue); Horizon Europe or Euratom funding; grant project name, acronym and number; licensing terms; persistent identifiers for the publication, the authors involved in the action and, if possible, for their organisations and the grant. Where applicable, the metadata must include persistent identifiers for any research output or any other tools and instruments needed to validate the conclusions of the publication.

Open science: research data management

The beneficiaries must manage the digital research data generated in the action ('data') responsibly, in line with the FAIR principles and by taking all of the following actions:

- establish a data management plan ('DMP') (and regularly update it)

- as soon as possible and within the deadlines set out in the DMP, deposit the data in a trusted repository; if required in the call conditions, this repository must be federated in the EOSC in compliance with EOSC requirements

- as soon as possible and within the deadlines set out in the DMP, ensure open access — via the repository — to the deposited data, under the latest available version of the Creative Commons Attribution International Public License (CC BY) or Creative Commons Public Domain Dedication (CC 0) or a licence with equivalent rights,

following the principle ‘as open as possible as closed as necessary’, unless providing open access would in particular:

- be against the beneficiary’s legitimate interests, including regarding commercial exploitation, or
- be contrary to any other constraints, in particular the EU competitive interests or the beneficiary’s obligations under this Agreement; if open access is not provided (to some or all data), this must be justified in the DMP

- provide information via the repository about any research output or any other tools and instruments needed to re-use or validate the data.

Metadata of deposited data must be open under a Creative Common Public Domain Dedication (CC 0) or equivalent (to the extent legitimate interests or constraints are safeguarded), in line with the FAIR principles (in particular machine-actionable) and provide information at least about the following: datasets (description, date of deposit, author(s), venue and embargo); Horizon Europe or Euratom funding; grant project name, acronym and number; licensing terms; persistent identifiers for the dataset, the authors involved in the action, and, if possible, for their organisations and the grant. Where applicable, the metadata must include persistent identifiers for related publications and other research outputs.

Open science: additional practices

Where the call conditions impose additional obligations regarding open science practices, the beneficiaries must also comply with those.

Where the call conditions impose additional obligations regarding the validation of scientific publications, the beneficiaries must provide (digital or physical) access to data or other results needed for validation of the conclusions of scientific publications, to the extent that their legitimate interests or constraints are safeguarded (and unless they already provided the (open) access at publication).

Where the call conditions impose additional open science obligations in case of a public emergency, the beneficiaries must (if requested by the granting authority) immediately deposit any research output in a repository and provide open access to it under a CC BY licence, a Public Domain Dedication (CC 0) or equivalent. As an exception, if the access would be against the beneficiaries’ legitimate interests, the beneficiaries must grant non-exclusive licenses — under fair and reasonable conditions — to legal entities that need the research output to address the public emergency and commit to rapidly and broadly exploit the resulting products and services at fair and reasonable conditions. This provision applies up to four years after the end of the action (see Data Sheet, Point 1).

Plan for the exploitation and dissemination of results including communication activities

Unless excluded by the call conditions, the beneficiaries must provide and regularly update a plan for the exploitation and dissemination of results including communication activities.

SPECIFIC RULES FOR CARRYING OUT THE ACTION (— ARTICLE 18)

Implementation in case of restrictions due to strategic assets, interests, autonomy or security of the EU and its Member States

Where the call conditions restrict participation or control due to strategic assets, interests, autonomy or security, the beneficiaries must ensure that none of the entities that participate as affiliated entities, associated partners, subcontractors or recipients of financial support to third parties are established in countries which are not eligible countries or target countries set out in the call conditions (or, if applicable, are controlled by such countries or entities from such countries) — unless otherwise agreed with the granting authority.

The beneficiaries must moreover ensure that any cooperation with entities established in countries which are not eligible countries or target countries set out in the call conditions (or, if applicable, are controlled by such countries or entities from such countries) does not affect the strategic assets, interests, autonomy or security of the EU and its Member States.

Specific rules for MSCA actions

When implementing MSCA Doctoral Networks (DN), Postdoctoral Fellowships (PF) and COFUND actions, the beneficiaries must respect the following conditions:

- take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[3] and ensure that the researchers and all participants involved in the action are aware of them

- ensure that the researchers enjoy at the place of the implementation at least the same standards and working conditions as those applicable to local researchers holding a similar position

- ensure that the employment contract, other direct contract or fixed-amount-fellowship agreement (see Article 6) specifies:

    - the name of the supervisor(s) for the research training activities

    - the starting date and duration of the research training activities

    - the monthly support for the researcher under this Agreement (in euro and, if relevant, in the currency in which the remuneration is paid)

    - the obligation of the researcher to work exclusively for the action, unless part-time for professional reasons is allowed and has been approved (and for MSCA-DN and MSCA-PF: not to receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiary or other entities mentioned in Annex 1)

    - the working pattern of the researcher

    - the arrangements related to the intellectual property rights (during implementation of the action and afterwards), in particular full access — on

[3] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

a royalty-free basis — for the researcher to background and results needed for their activities under the action

- the obligation of the researcher to inform as soon as possible about events or circumstances likely to affect the implementation of the action or the compliance with requirements under the Agreement (see Article 19)
- the obligation of the researcher to maintain confidentiality (see Article 13)
- the obligation of the researcher to ensure the visibility of EU funding in communications or publications and in applications for the protection of results (see Articles 17)
- where set out in the call conditions, the obligation of the researcher to carry out a mandatory return period of 12 months

- assist the researchers in the administrative procedures related to the recruitment
- inform the researchers about:
  - the description, conditions, location and timetable for the implementation of the research training activities
  - the rights and obligations toward the researchers under this Agreement
  - the obligation of the researchers to complete and submit — at the end of the research training activities — the evaluation questionnaire and — two years later — follow-up questionnaire provided by the granting authority
- ensure full access — on a royalty-free basis — for the researchers to background and results needed for their activities under the action
- ensure that the researchers do not have to bear any costs for the implementation of the action as described in Annex 1
- provide training and the necessary means for implementing the action (or ensure that such training and means are provided by other participants in the action)
- ensure that the researchers are adequately supervised and receive appropriate career guidance
- ensure that personalised career development plans are established, support their implementation and update in view of the needs of the researchers
- ensure an appropriate exposure to the non-academic sector (if applicable)
- respect the maximum limit for secondments set out in the call conditions
- respect the conditions for the outgoing and return phases set out in the call conditions (if any)
- ensure that the researchers are informed that they are ‘Marie Skłodowska-Curie fellows’
- for MSCA-DN and MSCA-COFUND:

- advertise and publish vacancies internationally, including on the web-sites requested by the granting authority, indicating the gross salary (not including employer's social contributions) to be offered to the researcher
- recruit the researchers, following an open, transparent, merit-based, impartial and equitable recruitment procedure (for postdoctoral programmes in MSCA-COFUND: with regular selection rounds and international peer review), on the basis of:
  - their scientific skills and the relevance of their research experience
  - the impact of the proposed training on the researcher's career
  - a fair gender representation (by promoting genuine equal access opportunities throughout the recruitment process)

  The selection committees must bring together diverse expertise, have an adequate gender balance and include members from different countries and with relevant experience to assess the candidates.
- ensure that no conflict of interest exists in or arises from the recruitment

- for MSCA-DN and MSCA-PF:
  - ensure that the researchers do not receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiaries (or other entities mentioned in Annex 1)
  - host the researchers at their premises (or at the premises of other participants in the action)
- for MSCA-COFUND where doctoral or post-doctoral programmes are implemented as financial support to third parties through implementing partners:
  - ensure that the implementing partners comply with the same standards and procedures for implementing the research training activities, including the recruitment and working conditions for researchers, the specific rules for MSCA-COFUND actions and the specific rules on ethics and research integrity set out in Annex 5
  - implement effective monitoring and oversight arrangements towards the implementing partners, covering all aspects relating to the action
  - ensure effective and reliable reporting by the implementing partners, covering the activities implemented, information on indicators, as well as the legality and regularity of the expenditure claimed
  - ensure that the implementing partners provide that the bodies mentioned in Article 25 (e.g. granting authority, OLAF, Court of Auditors (ECA), etc.) can exercise their rights also towards the final recipients.

When implementing Horizon Europe MSCA Staff Exchanges (MSCA-SE), the beneficiaries must respect the following conditions:

- take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[4] and ensure that the seconded staff and all participants involved in the action are aware of them
- ensure that the seconded staff enjoys at the place of the implementation at least the same standards and working conditions as those applicable to local staff holding a similar position
- assist the seconded staff with the administrative procedures related to their secondment
- inform the seconded staff about:
  - the description, conditions, location and timetable for the implementation of the secondment
  - the rights and obligations of the beneficiary toward the seconded staff under this Agreement
  - the obligation of the seconded staff to complete and submit — at the end of the secondment — the evaluation questionnaire and — two years later — the follow-up questionnaire provided by the granting authority
  - the arrangements related to the intellectual property rights between the beneficiary and the seconded staff (during the secondment and afterwards), in particular full access — on a royalty-free basis — for the staff to background and results needed for their activities under the action
  - the obligation of the seconded staff to maintain confidentiality (see Article 13)
  - the obligation of the seconded staff to ensure the visibility of EU funding in communications or publications and in applications for the protection of results (see Article 17)
- ensure that the seconded staff do not have to bear any costs for the implementation of the action as described in Annex 1
- provide training and the necessary means for implementing the action (or ensure that such training and means are provided by other participants in the action)
- ensure that the seconded staff are adequately mentored
- ensure that the rights and obligations of the seconded staff remain unchanged during the secondment
- ensure full access — on a royalty-free basis — for the staff to background and results needed for their activities under the action

[4] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

- if appropriate, ensure that seconded staff are reintegrated after the secondment
- ensure that the seconded staff are covered by an adequate medical insurance scheme
- ensure that the seconded staff have the relevant expertise for the action
- use the top-up allowance (see Article 6) to contribute to the subsistence, accommodation and travel of the seconded staff.

Specific rules for ERA Fellowship actions

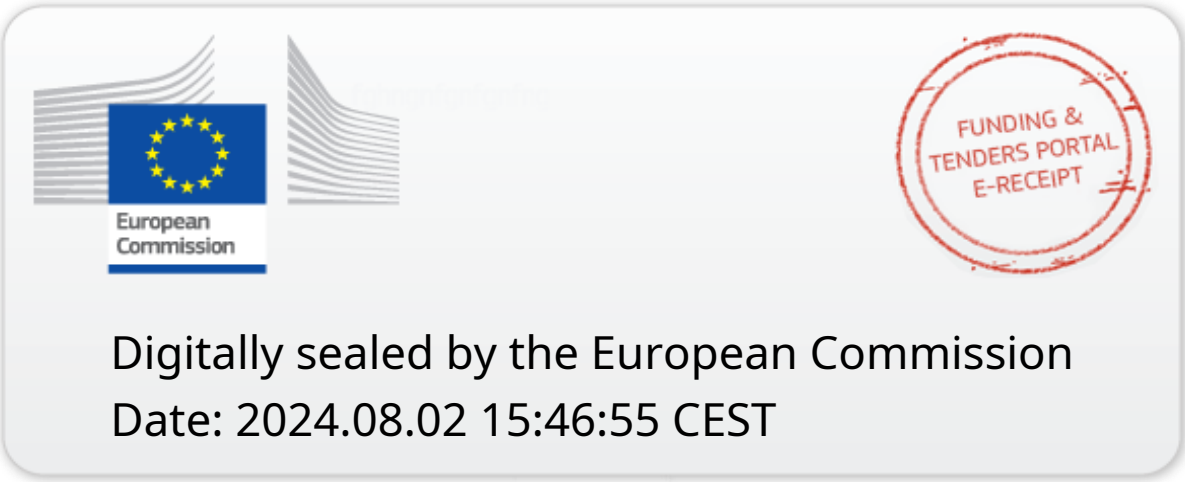
When implementing ERA Fellowships, the beneficiaries must respect the following conditions:

- take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[5] and ensure that the researchers and all participants involved in the action are aware of them
- ensure that the researchers enjoy at the place of the implementation at least the same standards and working conditions as those applicable to local researchers holding a similar position
- ensure that the employment contract, other direct contract or fixed-amount-fellowship agreement (see Article 6) specifies:
    - the name of the supervisor(s) for the research training activities
    - the starting date and duration of the research training activities
    - the monthly support for the researcher under this Agreement (in euro and, if relevant, in the currency in which the remuneration is paid)
    - the obligation of the researcher to work exclusively for the action, unless part-time for professional reasons is allowed and has been approved (and not to receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiary or other entities mentioned in Annex 1)
    - the working pattern of the researcher
    - the arrangements related to the intellectual property rights (during implementation of the action and afterwards), in particular full access — on a royalty-free basis — for the researcher to background and results needed for their activities under the action

[5] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

  - the obligation of the researcher to inform as soon as possible about events or circumstances likely to affect the implementation of the action or the compliance with requirements under the Agreement (see Article 19)
  - the obligation of the researcher to maintain confidentiality (see Article 13)
  - the obligation of the researcher to ensure the visibility of EU funding in communications or publications and in applications for the protection of results (see Articles 17)
  - where set out in the call conditions, the obligation of the researcher to carry out a mandatory return period of 12 months
- assist the researchers in the administrative procedures related to the recruitment
- inform the researchers about:
  - the description, conditions, location and timetable for the implementation of the research training activities
  - the rights and obligations toward the researchers under this Agreement
  - the obligation of the researchers to complete and submit — at the end of the research training activities — the evaluation questionnaire and — two years later — follow-up questionnaire provided by the granting authority
- ensure full access — on a royalty-free basis — for the researchers to background and results needed for their activities under the action
- ensure that the researchers do not have to bear any costs for the implementation of the action as described in Annex 1
- provide training and the necessary means for implementing the action (or ensure that such training and means are provided by other participants in the action)
- ensure that the researchers are adequately supervised and receive appropriate career guidance
- ensure that personalised career development plans are established, support their implementation and update in view of the needs of the researchers
- ensure an appropriate exposure to the non-academic sector (if applicable)
- respect the maximum limit for secondments set out in the call conditions
- respect the conditions for the outgoing and return phases set out in the call conditions (if any)
- ensure that the researchers are informed that they are ‘ERA fellows’
- ensure that the researchers do not receive, for activities carried out in the frame of the action, other incomes than those received from the beneficiaries (or other entities mentioned in Annex 1)

- host the researchers at their premises (or at the premises of other participants in the action)



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