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Proposal for a COUNCIL RECOMMENDATION

on Advanced Materials

[Advanced Materials for Europe]

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1. INTRODUCTION

Advanced materials are central to Europe's economic and technological advancement. They play a crucial role in driving the green and digital transition and strengthening industrial competitiveness as a 'powerful engine for economic growth' (OECD, 2025a). They do this by enabling innovation across strategic technologies and industrial value chains, thereby contributing to European resilience and strategic autonomy. In various high-tech sectors such as energy, mobility, construction, electronics, health, aerospace and defence, they provide the superior performance needed to drive sustainable growth within a challenging and shifting global landscape.

They can also facilitate circularity and recyclability and reduce industrial emissions, and they have the potential to substitute certain critical raw materials (CRMs). Advances in material-related research increase the competitiveness of European products and companies on the global stage, thereby creating new jobs in the sectors where these materials are needed.

In 2025, the Competitiveness Compass[1] highlighted advanced materials amongst the technologies that will serve as growth engines for tomorrow's economy if there is sufficient investment to close the innovation gap. They are expected to attract further demand and reshape global supply chains. The EU startup and scaleup strategy[2] further identified advanced materials as a strategic area, and underlined the need to reduce regulatory burdens in relation to them. Advanced materials are also amongst the 10 critical technology areas for the EU's economic security[3]. The European Commission's 2026 work programme entitled 'Europe's Independence Moment' listed an Advanced Materials Act, announcing that it would support the technological leadership of our industry and European strategic autonomy.

This staff working document accompanies the Advanced Materials for Europe agenda that responds to this and takes the form of a Commission proposal for a Council Recommendation[4] on Advanced Materials. The proposed Council Recommendation addresses the existing challenges and sets out policy recommendations to improve the framework conditions and overcome the fragmentation of the advanced materials ecosystem, while building on measures taken since the 2024 Communication on advanced materials for industrial leadership.

This document aims to present an overview of what advanced materials are and how they can be defined, the strengths and weaknesses of the EU's advanced materials ecosystem; and the emerging opportunities and key obstacles identified that prevent the EU from fully unlocking the transformative power of advanced materials to boost competitiveness across strategic sectors and value chains. It then presents the existing policy framework, identifies possible policy responses to address the transformational challenges and outlines where action is needed.

It builds upon several studies which have analysed the production and use of advanced materials, the patent landscape, the landscape of research and technology infrastructures, and the substitution potential of critical raw materials. It has also benefited from various consultation events and input from stakeholders. The annexes to this staff working document include a summary report of the outcome of a call for evidence and public consultation and an overview of national research and innovation (R&I) policies on advanced materials.

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[1] European Commission, 'A Competitiveness Compass for the EU COM(2025) 30 final.
[2] European Commission,'The EU Startup and Scaleup Strategy - Choose Europe to start and scale',COM(2025) 270 final.
[3] The annex of the Commission Recommendation on critical technology areas for the EU's economic security for further risk assessment with Member States, C(2023) 6689 final, lists advanced materials, manufacturing and recycling technologies amongst the 10 most critical technology areas. In terms of likely focus points for advanced materials, it mentions technologies for nanomaterials, smart materials, advanced ceramic materials and stealth materials.
[4] Proposal for a Council Recommendation on Advanced Materials [Advanced Materials for Europe], COM(2026)833.

2. DEFINING ADVANCED MATERIALS, EXAMPLES AND APPLICATION AREAS

Advanced materials are understood as materials that are rationally designed to have (i) new or enhanced properties, and/or (ii) targeted or enhanced structural features with the objective of achieving specific or improved functional performance[5]. This includes new emerging manufactured materials, materials manufactured from conventional materials and materials from innovative manufacturing processes that enable the creation of targeted structures from starting materials.

This is a *working description* provided by the Organisation for Economic Cooperation and Development (OECD), based on the work of the OECD working party on manufactured nanomaterials. While it is used in the context of the Commission proposal for a Council Recommendation on Advanced Materials for Europe, this definition may be further fine-tuned based on, for example, regulatory needs. In its current form it is, however, viewed as appropriate overall by 64% of the respondents to the open public consultation[6].

Engineered novelty and peformance advantage are two particular *key attributes* of this definition that help identify an advanced material in practical terms:

Engineered novelty: The material is deliberately engineered (often at micro-, nano- or molecular scale) to have a targeted or superior properties. It is purpose-designed with a clear aplication in mind, for example, a higher strength-to-weight ratio, special electrical/optical functions, extreme heat or corrosion resistance, biocompatibility, etc. This results from a precise control of new compositions, hybrid structures (e.g. organic-inorganic combinations) or new surface/interface designs to meet specific functional requirements. They are typically manufactured (and not naturally occurring in raw form or standard materials) and often arise from cutting-edge techniques in material science (such as nanotechnology, advanced chemistry, AI-driven materials design or novel processing methods).

Performance advantage: Advanced materials provide a distinct performance advantage or new functionality in a specific application, compared to traditional materials. In other words, the material enables improved efficiency, durability, safety or other tangible benefits in its use-case (for example, a battery electrode material that vastly improves energy storage capacity or a construction material that self-heals cracks).

Some *examples* of advanced materials are:

- self-healing materials, inspired by biological systems, which are capable of automatically repairing cracks or damage;
- smart glass windows with thermochromic nanoparticles that adjust their tint (i.e., their reflective properties) as temperature changes, improving energy efficiency of buildings[7];
- meta-materials that bend light, block sound or control heat and allow for invisible coatings for defence applications, super-fast 6G networks, and highly efficient energy solutions;
- high-performance coatings and thermoplastics, e.g., in aerospace, automotive, renewable energy, electronics, medical devices and construction;

[5] OECD working description on advanced materials, https://one.oecd.org/document/ENV/CBC/MONO(2022)29/en/pdf

[6] Of the remaining respondents 27% felt the definition was too narrow, and 6% felt it was too broad. For further details on the open public consultation, please see the annex 1.

[7] See for example the EU funded Switch2Save project, https://switch2save.eu/.

- high grade titanium alloys, carbon fibres or silicon carbide for aviation, automotive aerospace and defence applications.

However, these are just a few examples. Many products that we use in daily life, such as computers, cars and other modes of transport, buildings, solar panels and so forth, all depend on a large number of advanced materials. Early estimates for the impact of advanced materials on the energy sector conclude that 70% of all technical innovations are directly or indirectly attributed to advanced materials (Vandeweert, 2015).

Advanced materials can be found across many sectors and application areas. For instance, they comprise perovskite solar materials and solid-state batteries (large-scale storage) in the energy sector; carbon-fiber composites and solid-state battery components in the mobility sector; self-healing concrete or advanced bio-based insulation material in the construction sector; gallium nitride (GaN) and graphene-based components in the electronics sector (e.g. in 5G/6G, chargers and batteries); and nanomedicine delivery systems and bioengineered tissue scaffolds in the area of medical devices.

Established, widely-used materials with well-known compositions and manufacturing methods – lacking recent breakthroughs in performance or functionality – are *not* considered advanced materials. Examples are common metals for vehicle components, standard concrete and construction steel, silicon-based electronics components (common types) and comon medical-grade metals (stainless steel, standard titanium).

Some materials are '*in between' (borderline or emerging cases)*, as they show partial innovation or are currently evolving, making their classification unclear or transitional. Examples include ultra-high-performance concrete, bio-based plastics (with emerging but inconsistent performance), next-generation alloys with incremental improvements, and organic electronic materials (OLEDs becoming mainstream). This ambiguity brings challenges when using the working description in a strict legal context, but it should not prevent the development of policies to promote the development of advanced materials.

While there are many ways to classify or categorise advanced materials[8], the annex I of the draft Council Recommendation (which this document supports) provides a non-exhaustive overview list of *seven advanced materials classes* (with examples of materials, a short description of typical properties and examples of applications). They include advanced ceramics and glasses; advanced composites and hybrid materials; advanced metals, alloys and semiconductors; advanced polymers and precursors; nanomaterials; smart and functional (intelligent/responsive) materials; and stealth and metamaterials[9].

3. STRENGTHS AND WEAKNESSES OF THE EU ADVANCED MATERIALS ECOSYSTEM

This section presents an overview of the strength and weaknesses of the EU advanced materials ecosystem in different areas, taking evidence from several supporting studies and consultations.

[8] For instance, a similar example of a classification of advanced materials with their applications can be found in the evidence report on advanced materials by the Science Advice for Policy by European Academies (SAPEA, 2026) that supported the Scientific Opinion on Advanced Materials by the Scientific Advice Mechanism to the European Commission. The European Research Council (European Commission, 2026b) also provides a taxonomy of material classes based on their composition and structure, their functionalities and application domain.

[9] This classification is slightly different to the classification into nine materials classes that was used by several of the studies referenced in this staff working document (see European Commission, 2026e for details). For example, the separate class 'energy materials' was removed, as it is better covered as part of the other classes.

3.1. Research and innovation

The EU continues to play a key role in global R&I on advanced materials. In fundamental research, which is vital for advanced materials, Europe is a significant source of scientific progress. European universities and research programmes produce high-quality, innovative research output, such as scientific publications and patents. Equally, a significant effort is made to translate these results into innovation.

The Commission has invested **EUR 2.3 billion in the period 2021-2027 on advanced materials under Pillar II of the current Horizon Europe**, in areas such as advanced materials for mobility, construction, electronics, digitalisation (modelling, simulation, artificial intelligence), the safe and sustainable by design (SSbD) framework[10] for chemicals and materials, manufacturing, characterisation of advanced materials, circularity, technology infrastructures, aerospace, health and chemicals production. In addition, **the European Research Council (ERC) invested EUR 720 million between 2021 and 2023 on advanced materials related projects** (European Commission, 2026b), which represents a strategic share of its fundamental research funding, on average making up 13% of all ERC grants.

The **European Innovation Council (EIC) also invested EUR 500 million between 2021 and 2024 on advanced manufacturing and materials** (European Innovation Council, 2025), with a particular focus on the technology areas of 2D and nanomaterials; biomass, bio-based and engineered living materials; 3D printing & other additive manufacturing; and nanotechnology & miniaturisation. At least 131 companies operating directly in the area of advanced materials were supported through the EIC between 2020 and 2026, with a total EU contribution of over EUR 344 million, creating a dedicated portfolio of advanced materials projects and companies. Out of these, 42 are SMEs funded under the accelerator programme. The other 89 are in consortia formed mainly under the pathfinder programme, with some formed under the transition programme. The technologies developed by these projects are expected to be integrated in particular into sectors such as quantum, advanced computing and semiconductors, medical technologies and energy. More recently, the EIC launched a 50 million accelerator challenge entitled 'Advanced Materials for Renewable Energy and Energy Storage Systems' in 2026, while the draft work programme for 2027 also contains a pathfinder challenge entitled 'Breakthroughs in Advanced Materials for Future Resilient, Sustainable, and Efficient Energy Grids'.

There are also several funding streams related to defence where advanced materials often play a role, such as the European defence fund[11], the EU defence innovation scheme[12], the European defence industry programme[13], the programme for agile and rapid defence innovation[14] and the defence equity facility[15].

The support provided for advanced materials by the EU's framework programme is also underpinned by the EU's cohesion policy, notably the European Regional Development Fund

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[10] Commission Recommendation (EU) 2026/510 of 6 March 2026 on revising the European assessment framework for 'safe and sustainable by design' chemicals and materials, OJ L, 2026/510, 10.3.2026, ELI: http://data.europa.eu/eli/reco/2026/510/oj, with its annex setting out the details of the framework based on technical reports from the European Commission's Joint Research Centre (2025e), which also published a revised methodological guidance (European Commission, 2026n) in October 2026. For more background, see: https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/chemicals-and-advanced-materials/safe-and-sustainable-design_en.

[11] https://defence-industry-space.ec.europa.eu/eu-defence-industry/european-defence-fund-edf-official-webpage-european-commission_en.

[12] https://eudis.europa.eu/index_en.

[13] https://defence-industry-space.ec.europa.eu/eu-defence-industry/edip-forging-europes-defence_en.

[14] https://defence-industry-space.ec.europa.eu/eu115-million-programme-agile-and-rapid-defence-innovation-agile-2026-03-26_en.

[15] https://eudis.europa.eu/eudis-tracks/defence-equity-facility_en.

(ERDF). Under this policy, R&I investments in advanced materials are guided by national and regional innovation strategies ('smart specialisation strategies (RIS3)') and the corresponding ERDF programmes, which set out the priority areas and sectors based on territorial strengths and challenges. Additionally, in the area of energy related research, innovation and competitiveness, the *strategic energy technologies plan* (SET plan) covers many technologies where advanced materials play a crucial role, such as photovoltaics, hydrogen, wind energy and batteries. The SET plan is a cooperation forum between the Member States and the European Commission and has working groups on implementing clean energy technologies.

Europe also boasts comprehensive and sophisticated databases (e.g. Materials Cloud[16], FAIRmat[17], MaterialDigital Data Portal[18] and CAPeX[19]) on materials' properties and predictive testing systems. This wealth of data improves research capabilities, allowing scientists to conduct accurate simulations, accelerate discovery, and develop innovative materials tailored to industrial needs, supported by AI and computational power.

A study on the new challenges of technological sovereignty and Europe's changing position in the global R&I system (European Commission, 2026g) finds that Europe has a stable position in the scientific domain in related areas, such as advanced manufacturing and nanotechnologies, while China is significantly ahead in terms of the number of publications in advanced manufacturing and robotics (China produces over 30% of publications compared to less than 25% coming from Europe), and in micro- and nanoelectronics/photonics (with 40% of publications coming from China versus less than 20% from Europe).

However, according to a study from the Joint Research Centre (European Commission, 2025b) on the technological capabilities in Europe in the field of advanced materials, Europe is in a weak position with regard to specialising in subfields of advanced materials, except for composites, polymers and miniaturisation technologies.

Other studies with similar conclusions raise two challenges in particular for R&I on advanced materials in Europe. The *first* challenge is the fragmented nature of the R&I ecosystem, as is for example extensively illustrated in the area of intellectual property (European Commission, 2024), and in the area of research and technology infrastructures (European Commission, 2026a). The *second* challenge is the disconnect between research and industry. The open public consultation underlined this strongly, with more than 90% ranking strengthening links between industry, academia and research institutions as effective or very effective in reducing time to market for new advanced materials.

To address these challenges, there are a number of strengths that play in Europe's favour. Europe has made significant developments in creating innovation ecosystems that support collaboration in the field of advanced materials, such as innovation hubs[20], shared research and development (R&D) labs[21], university science parks, industry-driven incubators[22] and other innovation projects[23]. The non-profit association Innovative Advanced Materials Initiative (IAM-I)[24] has been launched, which is tasked with bringing together stakeholders across research, industry and public sectors to accelerate innovation, reduce time to market for advanced materials and strengthen Europe's strategic autonomy in materials R&D (see Section 3.8 on network initiatives).

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[16] https://www.materialscloud.org/.
[17] https://www.fairmat-nfdi.eu/fairmat.
[18] https://dataportal.material-digital.de/.
[19] https://capex.dtu.dk/.
[20] See https://european-digital-innovation-hubs.ec.europa.eu/home.
[21] For example, IMEC in Belgium or M2i in the Netherlands.
[22] For example, CENIMAT|i3N in Portugal, or the Axelera ecosystem in France.
[23] See for example demola.net.
[24] https://www.iam-i.eu/.

Europe has a strong R&I ecosystem and the EU has invested heavily in advanced materials with funding from Horizon Europe, including the European Research Council and the European Innovation Council. However, its advanced materials R&I ecosystem is fragmented and suffers from a disconnect between research and innovation.

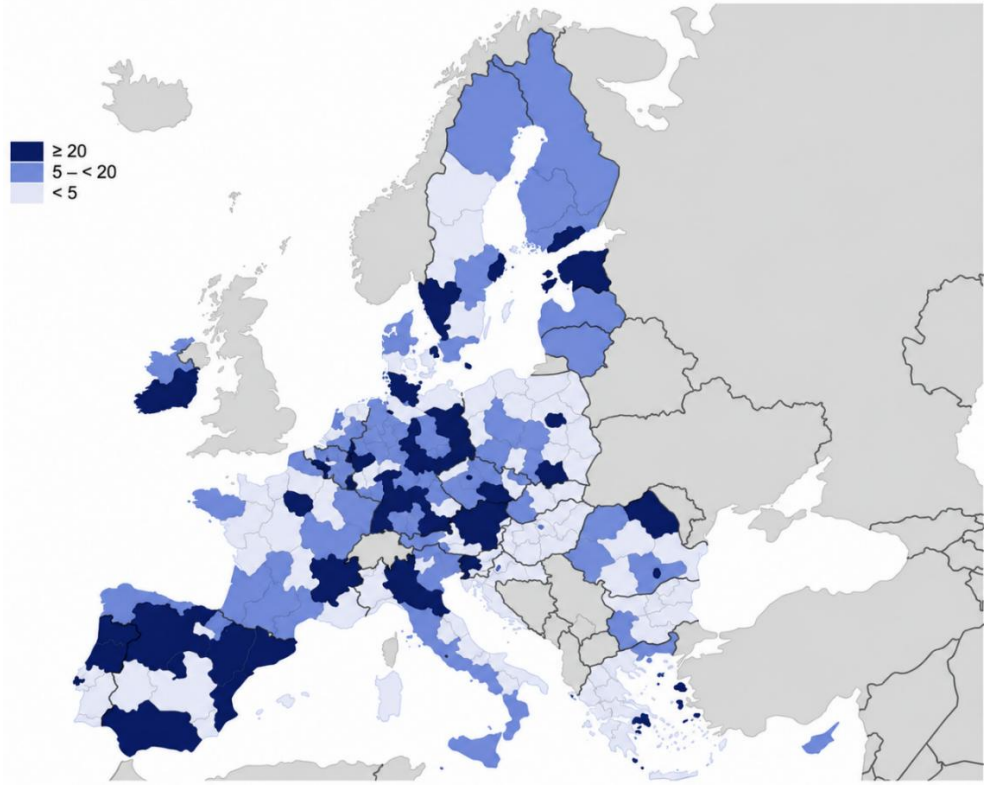
3.2. The role of research and technology infrastructures

Europe has world-class facilities for frontier research, characterisation and pilot testing. Institutes such as the European Organization for Nuclear Research (CERN), European Synchrotron Radiation Facility, European Molecular Biology Laboratory, Institut Laue–Langevin (ILL), European Spallation Source, European X-Ray Free-Electron Laser Facility (XFEL) and many others attract scientists from abroad for their unique and high-profile research infrastructure (SAPEA, 2026).

A study on the uptake of advanced materials (European Commission, 2026a) mapped and identified **2 943 advanced materials research and technology infrastructures across the EU** operating under diverse business models spanning the full technology readiness level (TRL) spectrum. These are laboratories (43%), centres (21%), pilot lines (14%), innovation platforms (11%), testbeds (5%), cleanrooms (4%) and demonstrators (2%). They are primarily oriented towards electronics (42%), energy (30%) and mobility (13%), while relatively few focus on medical devices (10%) and construction (4%).

Within these infrastructures, technology infrastructures represent around 36%. Such technology infrastructures are concentrated in strong and leading innovator regions, especially in Germany, eastern France, Spain, northern Italy and the area around the Baltics and southern Finland), while Austria and Sweden show a high relative density when normalised by population and GDP. Figure 1 shows the distribution of advanced material infrastructures, as provided by this study.

Figure 1. Number of advanced materials infrastructures available in European regions



The EU advanced material research infrastructures (RIs) and technology infrastructures (TIs) considered in this study are predominantly oriented towards the electronics, energy and mobility sectors. More than 40% of RIs and TIs surveyed in the context of this study are already working with advanced materials in *defence and dual-use applications*, underlining their growing role in supporting the EU's strategic autonomy and the technological and industrial base of the EU's defence sector. Recent policy developments, including revised EU funding rules and the expansion of testing networks (such as to the test centre network of NATO's innovation accelerator called DIANA – short for Defence Innovation Accelerator for the North Atlantic) provide a window of opportunity to better integrate defence-relevant advanced material technology infrastructures into Horizon Europe and the strategic technologies for Europe platform (STEP), namely through EIC STEP Scale Up Defence, and European Research Area (ERA) governance. The study also indicates that out of the 147 DIANA test centres that operated in the EU in 2022, 34 have a focus on advanced materials (i.e. 23%).

The user portfolio of research and technology infrastructures remains predominantly internal, with staff from host organisations representing the largest share of users, indicating that most infrastructures continue to operate primarily as research assets rather than demand-driven service providers. While large enterprises and small and medium-sized enterprises (SMEs) constitute a relevant external user group, particularly for technology infrastructures, industrial access remains moderate and uneven. This suggests that business access is limited by several challenges.

The Commission is launching a project through a call for proposals launched in 2026 under Horizon Europe to address the visibility of infrastructures in the EU. The project will build upon the European Commission (2026a) study 'Mapping & analysing European Research & Technology Infrastructures for Advanced Materials Uptake' and improve the visibility and access to technology infrastructures via an interactive portal of technology infrastructures across Europe[25]. This will help create an improved understanding of the European landscape of technology infrastructures. It will boost innovation and market potential by providing an interactive portal where industrial users, especially SMEs, start-ups and scale-ups, can search and find services relevant for their innovation and product development.

This is in spite of the fact that most infrastructures combine public mission research with market-facing services under public-private or mixed funding models. This hybrid model enables TIs to serve both academic and industrial users, with potential revenue sources through facility-as-a-service access, contract and collaborative R&D, open-access shared facilities, and in some cases product-centric manufacturing and licensing.

The technology services offered by the technology infrastructures relevant to advanced materials mostly consist of testing, characterisation and technology validation services (80%), feasibility studies and proof-of-concept (74%) and demonstration and prototyping services (65%). Other services like modelling and simulation (49%), product testing, experimentation, validation (47%), pilot production (44%), basic research (40%, small series production (34%) and certification support services (19%) are less prominent. In terms of the business support services of RIs and TIs, the most common type of support is collaboration and project development (53%), though many also frequently provide support for standardising new testing processes and products (30%). Less frequent are support for access to finance and funding sources (18%), legal and compliance support (16%), business incubator/accelerator support (16%), data management and curation (12%), and regulatory strategy and health technology assessment (6%) – with the latter also pointing to limits in what RIs and TIs can offer.

The study also flags that no examples of RIs and TIs focused on advanced materials collaborating with regulatory sandboxes were observed and that stakeholders highlight the value of voucher

[25] HORIZON-CL4-2026-01-MAT-PROD-46: Mapping and service finder for Technology Infrastructures (CSA) at the EU Funding & tender portal.

schemes, innovation grants and reduced-cost access for early-stage testing and piloting. It gives for instance an example from the German state of Baden-Württemberg which issued a regional innovation voucher scheme (*Innovationsgutscheine*)[26] in collaboration with the regional development bank to supports SMEs and start-ups in accessing external research and innovation services provided by RIs and TIs.

While the demand for infrastructure support for data, digital tools and artificial intelligence is growing, there is also an increasing need for support. This includes support for autonomous or *self-driving labs*, which are understood as highly autonomous experimentation facilities that combine machine learning, lab automation and robotics to accelerate the innovation pipeline from hypothesis generation to experiment execution, testing, data analysis and iterative optimisation. Building self-driving labs requires major investments, and large industrial players from outside Europe may start to dominate the research fields if researchers from academia and SMEs or mid-sized companies don't have access to such infrastructures. It is therefore crucial to build up such resources as common infrastructures also in Europe.

The EU has an extensive network of 2 943 advanced materials research and technology infrastructures (RIs and TIs), however this potential is underused. The user portfolio of RIs and TIs remains predominantly internal, with staff from host organisations representing the largest share of users across both RIs and TIs. In particular SMEs are not aware of all the infrastructures that are available, or do not have good access conditions. In addition, there is a need to build up capacities and expertise for self-driving labs to accelerate the discovery and development of advanced materials.

3.3. Digitalisation

Data, digital tools and robotics are drastically increasing the speed at which new breakthrough materials can be discovered by combining automated labs with AI and robotics. While automation is a natural development in labs that carry out R&I in chemistry and advanced materials, the new generation of AI technology and robotic platforms have the potential to start a technology revolution that changes the landscape of R&I in these areas. This is also reflected in the recent Scientific Opinion on Advanced Materials (European Commission, 2026i) by the Group of Chief Scientific Advisors as part of the Scientific Advice Mechanism (SAM). It made several recommendations regarding AI-ready data, digital tools for modelling and experimentation, support for self-driving labs, digital twins and the use of AI across the whole value cycle.

Advanced materials are a frontrunner for this development, as witnessed by developments in other parts of the world where this transformation is taking place at a rapid pace and is supported through national initiatives, e.g. in the US[27], Japan[28] and Canada[29]. China is also investing in a new materials big data centre by 2035 as part of its 15th five-year plan (2026-2030), in which advanced materials are a priority for its push for self-reliance in critical technologies and the advancement of high-tech industries.

A number of EU Member States have launched national initiatives to support this transition, such as Material Digital in Germany[30], PEPR DIADEM in France[31] and the CAPeX Pioneer Center in

[26] Support of around EUR 7 500 - 20 000 is offered to companies, covering up to 50% of eligible costs related to innovation activities such as external R&D, testing and technical development. For more information see https://wm.baden-wuerttemberg.de/de/innovation/innovationsgutscheine.
[27] https://genesis.energy.gov/.
[28] https://dxmt.nims.go.jp/en/about.
[29] https://acceleration.utoronto.ca/.
[30] https://www.material-digital.de/.
[31] https://www.pepr-diadem.fr/.

Denmark[32]. The recently launched Materials Commons for Europe[33] federates national initiatives and builds new capacities across Europe. As this is a project supported by Horizon Europe that runs until 2030, a permanent solution is needed to avoid re-fragmentation of data and tools.

European efforts build on existing initiatives such as European Open Science Cloud (EOSC)[34], the Common Data Platform on Chemicals[35], Resource for AI Science in Europe (RAISE)[36], data spaces, data labs, AI factories and high-performance computing[37], the SSbD framework[38] and digital product passports[39]. Enabling this transformation crucially depends on data sharing based on FAIR principles (findable, accessible, interoperable, reusable), interoperability of tools, common standards in this area, access to artificial intelligence technology and computing resources and knowledge sharing with regards to self-driving labs. As mentioned in the SAM opinion (European Commission, 2026i), these can also be extended to FAIR+, including specifically additional safeguards for responsible data governance.

One main objective for advanced materials should be to build a fully interoperable and integrated ecosystem of data, tools, AI technology and robotics accessible across Europe. The literature describes cases where self-driving labs produce results 1000 times faster than traditional research practice. One example (Anker et al, 2026) reports how AI, autonomous synthesis robotics and large-scale facilities are used to learn new synthesis recipes for nanoparticles and that they could reduce the time needed from six months to six hours.

While not all of the initial expectations and claims of very high improved efficiency when using AI for materials discovery have come true, considerable progress has been made and AI still holds great promise (Peplow, 2025). This concerns not only materials discovery, especially when combined with focused experiments, but also potential advances in terms of cost, sustainability and/or performance improvements.

In this context, due to AI pervasiveness, strengthening AI skills and literacy is crucial. Education lays the foundation for the advanced materials workforce, as well as for young people considering careers in the field, to develop the advanced and specialised AI capabilities increasingly required across industries.

Europe needs a sustained and coordinated approach to ensure FAIR+ data and digital tools like AI are made available and become interoperable across Europe. The emergence of self-driving labs also requires coordinated investments and giving access to a wide range of researchers to avoid falling behind in the area of R&I.

3.4. Intellectual property

Analysing patenting and exploitation patterns in advanced materials – particularly the roles of EU industry, universities and public research organisations – is essential for understanding Europe's competitive stance in intellectual property relative to the United States and China. Patenting

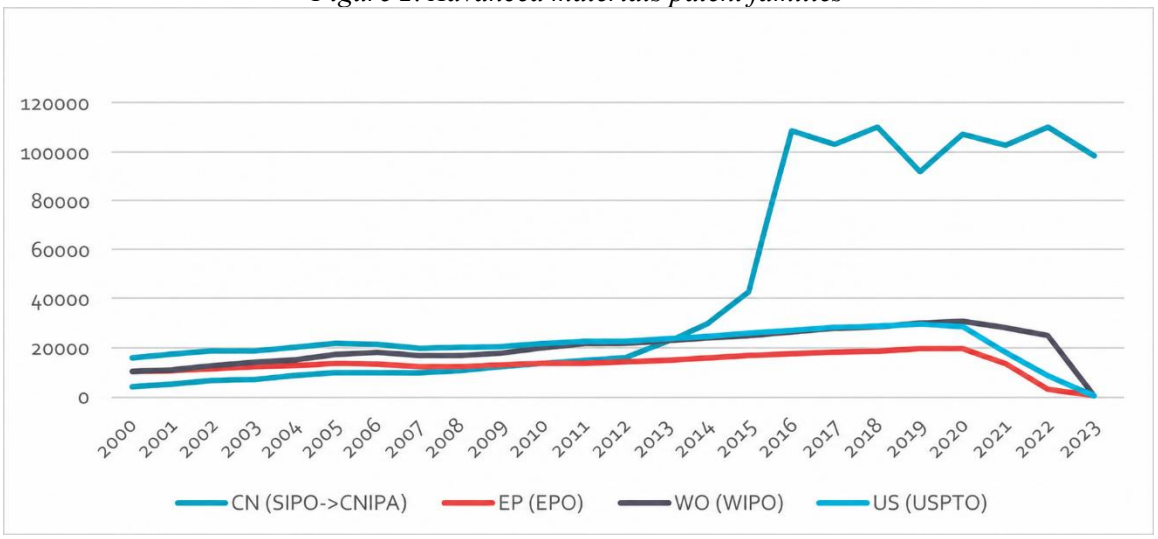
[32] https://capex.dtu.dk/.
[33] https://www.materialscommons.eu/.
[34] https://eosc.eu/eosc-about.
[35] See Regulation (EU) 2025/2455 of the European Parliament and of the Council of 26 November 2025 establishing a common data platform on chemicals, laying down rules to ensure that the data contained in it are findable, accessible, interoperable and reusable and establishing a monitoring and outlook framework for chemicals
[36] https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/european-ai-science-strategy/raise-resource-ai-science-europe_en.
[37] https://www.eurohpc-ju.europa.eu/index_en.
[38] https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/chemicals-and-advanced-materials/safe-and-sustainable-design_en.
[39] https://data.europa.eu/en/news-events/news/eus-digital-product-passport-advancing-transparency-and-sustainability.

activity not only reflects innovation output but also signals strategic priorities in the global race for technological leadership in advanced materials.

According to the research, development and innovation (RDI) monitoring database[40], Europe has a 15.7% share of distinct patent families in advanced materials from 2010 onwards, and 9.3% of high-value patents. A similar picture emerges from an analysis of Europe's position in the global R&I system (European Commission, 2026g), with **Europe having a share of 10-15% in global patents applications** in related areas, reaching 20% in some areas such as advanced manufacturing and robotics, and 12% in micro- and nanoelectronics/photonics.

A recent analysis of the patent landscape (European Commission, 2026d) in the field of advanced materials comes to similar results. Overall, EU companies filed almost 13% of world patents in 2010-2023, compared with almost 23% for US and around 25% for Chinese companies. While the EU remains an important player in innovation, its relative position in patents weakened by 2.3 percentage points over the period. The study describes how patenting expanded worldwide, illustrating that growth trajectories diverged sharply among major innovation regions. For instance, while Europe maintained a strong and diversified patenting base, its overall growth in advanced materials patent families remained relatively stable compared to the steep increases observed in China. This is also illustrated in Figure 2.

Figure 2. Advanced materials patent families



This pattern mirrors broader trends in advanced technologies, where Europe's scientific excellence and industrial R&D investments have not always translated into proportional gains in patent volumes or market deployment. In the period 2010-2024, only 4.7% of global advanced materials company patents had their priority filing in the EU, suggesting that global innovation is concentrated outside Europe.

At the same time, EU company patenting displays a comparatively strong international orientation: 24.1% of EU priority-filed company patents are triadic patent families, compared with 13.7% in the United States and 0.6% in China.

In contrast, China's rapid patenting growth is largely driven by domestic filings with limited international reach, a trend that reflects differences in incentive structures, coordinated policy support and industrial scaling capacity. The United States, meanwhile, combines high patenting volumes with extensive global diffusion, supported by well-established university-industry

[40] https://ppmi.lt/en/news-insis/ec-launches-initiative-track-rdi-biotech-and-advanced-manufacturing.

collaborations and mature innovation financing ecosystems. These deeply integrated university-industry patenting networks and venture capital channels accelerate technology transfer.

Another recent report from the European Research Centre (European Commission, 2026b) equally concludes that the **high global ranking of EU scientific publications is not translated into a similar ranking for industrial R&I investments in advanced materials**. It also finds that China continued its upward trajectory, a trend that underscores the role of capability accumulation, policy coordination and global positioning – factors that extend beyond R&D intensity alone. The analysis also indicates that the EU's innovation system, while strong in existing technological capabilities, has seen more limited expansion into fast-growing and disruptive domains.

An economic complexity analysis (European Commission, 2025b) also concludes that the **EU's relative competitive standing is being increasingly challenged and weakened** in terms of patents, and warns that EU leadership also in many traditional technologies is threatened by the increasing innovation activities of its competitors, notably China and the US[41].

European universities, research organisations, and companies face interconnected financial, organisational and regulatory barriers to patenting and commercialising advanced materials. High patenting costs[42], limited expertise, slow examination processes, the 'no-data-no-market' principles in chemicals legislation and jurisdictional complexities introduce uncertainty and delays. Sector-specific challenges — such as the capital-intensive nature of qualification, scale-up difficulties, and multidisciplinary demands — further amplify risks. Additionally, a weak patent culture, insufficient IP training, and a lack of academic incentives to pursue commercialisation prevent research outcomes from being exploited. This illustrates the existing bottlenecks preventing the EU's advanced materials ecosystem from fully translating its scientific strength into commercialisation, products, manufacturing capacity and market leadership.

While the advanced materials sector in the EU demonstrates a strategic and quality-focused approach to patenting with a share of 10-15% in global patent applications in related areas, it needs to overcome structural barriers to fully turn its scientific strengths into industrial strengths. Besides needing to better translate its scientific excellence into industrial leadership, the EU also faces increasing innovation activities by its main competitors, which threatens to weaken its competitive standing.

3.5. Industrial ecosystem

In terms of companies, the above study on the patent landscape (European Commission, 2026d) shows that the EU hosts an extensive network of companies. Although difficult to compile because of the nature of advanced materials, it is estimated that the EU hosts **15 000 companies** with a strength in an advanced materials related technology in the initially selected priority sectors of

[41] When looking at the current and perspective specialisation patterns in advanced materials, the study considers several subcategories as weaknesses (thin films, micromaterials, nanomaterials, fibres and metals), while indicating miniaturisation and polymers as current subfields with a revealed comparative advantage that are under threat, while only composites are outlined as a clear strength that combines current competitiveness and high potential for further development. Biomaterials, cements, and glass subcategories are outlined on the other side as having currently a lower comparative EU patent share, while offering a favourable technological progression probability.

[42] Even if this was reduced through the unitary patent system launched in 2023, see https://www.epo.org/en/applying/european/unitary/unitary-patent.

construction, energy, mobility, electronics and medical devices.[43] They generated a combined annual turnover of over **EUR 750 billion** and employed close to **1.5 million** people in 2022[44].

The analysis points to strong performance in high-value specialised materials, such as nanomaterials, polymeric materials, advanced composites and certain electronic and photonic materials, but to significant deficits in critical raw materials-intensive categories, such as permanent magnets and high-entropy alloys (European Commission, 2026e)[45].

The landscape of advanced materials producers in the EU is characterised by a **strong presence of specialised, innovation-driven SMEs, complemented by several major companies** often embedded in well-established mature industries. In terms of entrepreneurship and business dynamics, **23% of global start-ups** are active in the EU in the area of advanced materials (731 out of 3177)[46]**,** versus over 37% in the United States[47], where capital raising is 2.5 times higher than in the EU (see European Commission, 2026h). This difficult financial environment translates into relatively lower investment levels in research, development and innovation across the sector. In 2023, the EU recorded EUR 61.5 billion in R&I investments in advanced materials, well below the level observed in the United States (EUR 218.8 billion).

In the sample of companies analysed (European Commission, 2026e), 30% of companies have fewer than 30 employees, while another 30% have more than 1 000 employees. This supports strong research and technological capabilities and positions the EU competitively in high-value, specialised advanced materials, rather than in high-volume segments. At the same time, EU companies tend to be slightly smaller than their US counterparts in terms of average turnover and number of employees, while Chinese companies are significantly larger, mainly due to state-driven consolidation and the scale of the domestic market. This points to the EU value chain remaining more fragmented, where industrial scale-up continues to be a key challenge and EU demand is higher than supply (see next section). It also underlines the important role of start-ups and scale-ups for the European advanced materials ecosystem and their links with established companies.

Another study on industrial R&D&I investments and market analysis in advanced materials (European Commission, 2024a) gives an overview of the relative concentration of companies across the EU. As can be seen in the Figure 3 below, there is a particular specialisation in Germany (28%), Italy (21%) and France (10%).

[43] The figures exclude companies from the aerospace and defence sectors with strength in advanced materials related technologies. While these have been proposed to be added to the sectors in the scope of the proposed Council Recommendation on Advanced Materials for Europe, they were not amongst the first four sectors listed here that were identified as priority sectors in the European Commission's 2024 Communication on Advanced Materials for Industrial Leadership, while health (notably medical devices) was added as a fifth sector by the Technology Council for Advanced Materials in June 2025.

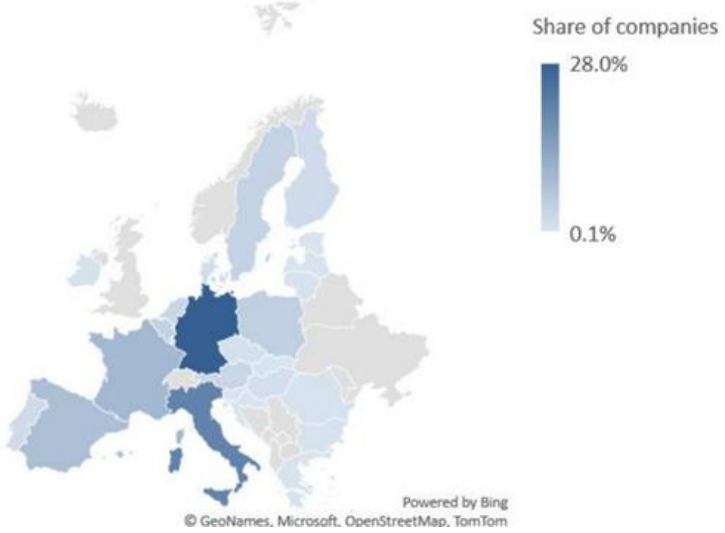
[44] This estimate is based on companies that meet a number of criteria, any of which should apply: (1) at least 5% of the total patent stock in an advanced material-related technology, (2) the company has at least 100 patents in an advanced material-related technology since 2010 or (3) company data has a strong technology keyword overlap with an advanced material-related technology.

[45] Based on a sample of 100 companies.

[46] Data collected from Dealroom database. A start-up was defined as a company that is less than 10 years old.

[47] This analysis is based on data in the Dealroom database, and concerns companies set up between 2017 and 2025.

Figure 3. Distribution of advanced materials companies in Europe as share of all companies.



The wider EU's advanced materials ecosystem is estimated to host an extensive network of around 15 000 companies with strengths in advanced materials-related technologies in construction, energy, mobility, electronics and medical devices. They generate an annual turnover of over EUR 750 billion and employ close to 1.5 million people. The EU's advanced materials ecosystem is characterised by a strong presence of specialised, innovation-driven SMEs and a 23% share of global start-ups[48], complemented by several major companies. It is however viewed as fragmented compared to other regions, with industrial scale-up remaining a key challenge.

3.6. Supply and demand, trade balance and value chain focus

Advanced materials are strategic enablers of the EU's industrial competitiveness across key industrial ecosystems, including construction, electronics, energy, health (medical devices) and mobility. They enable improved functionality in high-performance applications, while being a key driver for reducing the carbon footprint, improving energy efficiency and extending product lifetimes, hence contributing to sustainability and green transition objectives.

Value chain analysis (European Commission, 2026e) shows that the EU advanced materials ecosystem has a relatively high number of specialised, innovation-driven SMEs with strong research capabilities, highlighting the EU's research excellence, technological sophistication and dense collaboration networks. The EU value chains are more fragmented than those in the Asia-Pacific region and the US. Consequently, the EU lacks the industrial deployment capability of the more vertically integrated value chains and the significant governmental backing in those regions, which are more conducive towards scaling-up efforts. While there are still several steps of the chain populated by major European companies, they are mostly linked to well-established and mature industries, such as those producing plastic and construction materials.

Other challenges faced by EU producers include high capital intensity, long investment and permitting cycles, regulatory complexity and dependencies on key non-EU parts of the value chain. Meanwhile, on the demand side, infrastructure readiness, skills availability and access to finance emerge as key limiting factors for the uptake of advanced materials, with SMEs disproportionately affected. As a result, if the EU stimulates the demand side without addressing also these other aspects, it faces the risk of not fully capturing the associated industrial, economic and strategic benefits.

[48] See European Commission, 2026h.

Based on the results of the same production and use study (European Commission, 2026e), in 2024, the EU recorded a **EUR 1.45 billion trade value surplus** in advanced materials. However, performance varies considerably across material classes in terms of value: the EU is strong in high-value specialised materials, including nanomaterials, advanced polymers and composites, but faces significant deficits in volume-rich and critical raw materials-intensive categories, such as permanent magnets and high-entropy alloys.

The following two figures, based on the same study, compare the overall positive trade balance trend over the past 20 years with the trend in the mobility sector, where the EU records a substantial deficit.

Figure 4. EU advanced materials overall trade balance (EUR millions)

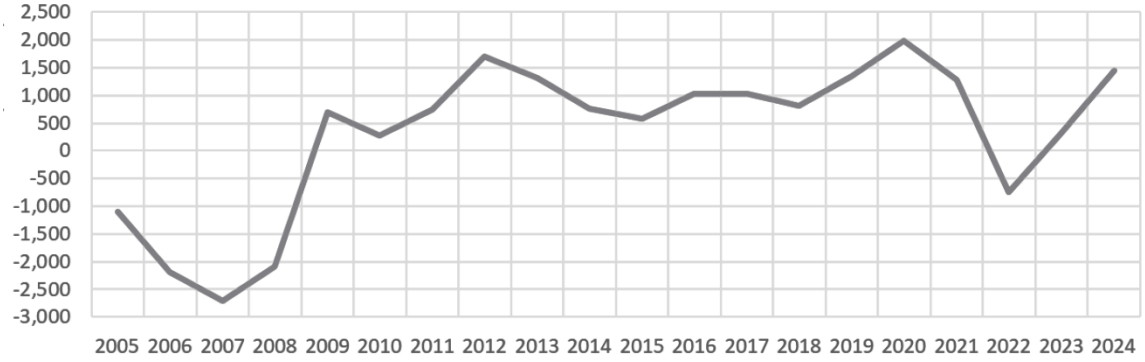
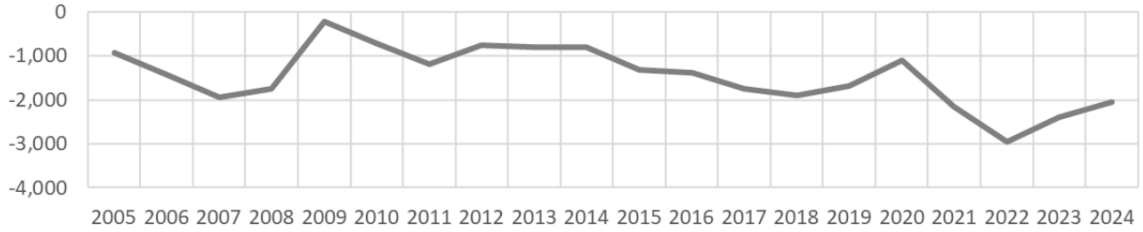


Figure 5. EU advanced materials trade balance for mobility applications (EUR millions)



When translated into volume, the trade value surplus turns into a **trade volume deficit of 0.3 million tonnes**. The EU exports 3.2 million tonnes while importing 3.5 million tonnes. This again reflects EU's role as high-value processor, while it predominantly imports bulk (raw) materials in large quantities from other regions. Similarly, EU utilisation capacity, estimated at 8.3 million tonnes in 2024, continues to exceed domestic production (7.9 million tonnes), highlighting structural gaps that require imports to meet domestic demand. Insights from the survey and interviews indicate concrete dependencies and vulnerabilities across several advanced materials classes, including battery-related materials, advanced alloys and selected polymers and composites that need large-scale manufacturing.

In the survey and interviews carried out with companies working with advanced materials as part of the study (European Commission, 2026e), the limited EU industrial scale up capacity in advanced materials is cited frequently as a barrier to production, as well as regulatory complexity and a high compliance burden. Testing and certification requirements[49] are significantly increasing development time and costs, particularly in safety-critical sectors, such as aerospace, defence and energy.

[49] In the study (European Commission, 2026e), Aerospace standard EN9100 was given as an example.

Given certain key dependencies (see next subsection), it is crucial to set indicators and monitor them to closely follow trade and value chain vulnerabilities to enable better informed policymaking.

Europe is an important player on the world market for advanced materials with a trade value surplus but a trade volume deficit, focusing more on high-value added products than on high-volume products or on those that rely intensively on critical raw materials. The challenges it faces include a lack of scale-up capacity, regulatory complexity, lack of monitoring capacity, and lengthy testing and certification requirements.

3.7. Strategic dependencies and substitution potential of critical raw materials in sectoral priority areas

Many advanced materials give rise to **dependencies** for Europe **that link to geopolitical tensions and supply chain risks**, similar to the way this happens in the case of critical raw materials. This includes cases where Europe depends on **inputs of critical raw and processed materials to make advanced materials**, as well as cases where the **technologies used to make advanced materials** are dominated by specific regions, even when they do not involve any critical raw materials. The latter case creates dependencies in particular on the US, China or Japan, as technologies may be so advanced that only a few suppliers can provide them.

Examples of dependencies include advanced composites (e.g. used for lightweighting in aerospace, automotive, wind turbines and defence)[50], rare earth magnets (e.g. used in automotive, wind turbines, robots, aerospace and defence applications), high-performance polymers (e.g. used in aerospace, medical implants and defence applications), gallium nitride and silicon carbide (e.g. used in semiconductors, automotive, aerospace, renewable energy, aerospace and defence applications), advanced ceramics (e.g. used in industrial tools, medical implants, aerospace, energy storage and defence applications) and high-strength alloys (e.g. used in aerospace, batteries and defence applications).

Many of these dependencies are created due to China's dominance in areas such as magnets and batteries, US export controls, and Japan's dominance in certain technology areas (e.g. carbon fibre or advanced ceramics). Moreover, a dependence on Russia also still exists for a few aerospace and defence grade alloys (e.g. titanium or nickel alloys). The same concerns niobium, which is an important component of superalloys needed to produce aerospace and defence technologies. Niobium has a very high dependence on Brazil and indirectly on China, due to Chinese ownership stakes in Brazilian niobium-producing companies.

From an **economic security perspective**, advanced materials are of particular interest due to their role in ensuring that the EU remains a critical and non-substitutable player in key technologies. They also have a role in limiting or replacing current strategic dependencies, including on critical raw and processed materials. This is reflected in the European economic security strategy of 20 June 2023[51], which aims to maximise the benefits of economic openness while minimising the risks of strategic dependencies. Additionally, advanced materials are included in the list of critical technology areas for the EU's economic security strategy put forward in the Commission Recommendation of 3 October 2023[52].

The importance of value chain dependencies is also highlighted in a recent study on the production and use of advanced materials (European Commission, 2026e) as one of the obstacles to developing

[50] See for example the EU-funded Macrame project, https://macrame-project.eu/.
[51] Joint Communication to the European Parliament, the European Council and the Council on "European Economic Security Strategy", JOIN(2023) 20 final.
[52] Commission Recommendation (EU) 2023/2113 on critical technology areas for the EU's economic security for further risk assessment with Member States.

large-scale industrial deployment and economic value capture. The study concludes that Europe lacks mechanisms to ensure that advanced materials that play a crucial role in key sectors are available during periods of disruption to supply. These dependencies are making it difficult for a vibrant advanced materials ecosystem to develop swiftly in Europe.

One specific opportunity offered by advanced materials is reducing the use of critical and strategic raw and processed materials. Identifying the research needed to develop alternative advanced materials in order to reduce dependencies on critical raw materials was one of the key actions identified in the European Commission Communication on Advanced Materials for Industrial Leadership[53]. This continues to be crucial, as it may involve trade-offs linked to the need to strengthen circularity and recycling, alongside investments in pilot lines, faster testing and updated standards. This approach complements the recycling of critical raw materials, which is also an important element of an overall strategy to reduce dependencies.

As for **standards**, their general impact on annual GDP growth is expected to be up to 1 percentage point[54]. An evaluation study of the European Standardisation Regulation (European Commission, 2025c) found that businesses face opportunity costs of up to EUR 3 700 per product, for each third-party conformity assessment, while awaiting the publication of harmonised standards in the Official Journal of the European Union. In this context the proposed new Standardisation Regulation[55] will play a key role.

Advanced materials are regularly identified (OECD, 2025a) as essential elements to ensure **resilience and strategic autonomy**, as they can help to improve durability, recyclability and circularity, as well as facilitate substitution or partial replacement of critical raw materials. Yet, **using advanced materials to substitute or reduce the use of critical raw and processed materials** often involves trade-offs in terms of functional performance, safety, durability, lifetime, cost, circularity or environmental and social impacts (European Commission, 2025a), or poses the risk of merely shifting dependencies to other critical raw materials[56]. The EU supports this effort to reduce dependency on critical raw materials, including addressing such trade-offs, through R&D efforts; following the recent Horizon Europe call 'Advanced materials for magnets in application for the New Energies Market', three projects were awarded with a total budget of more the EUR 22 million. For example, permanent magnets without critical raw materials (using high-entropy alloys or ferrite-based composites) are the aim of the Beethoven project[57].

The **maturity of substitution and reduction solutions varies across sectors and applications** (European Commissions, 2025a) and typically does not constitute a 'drop-in' solution, where one material is directly substituted with another. Some sectoral applications have distinct requirements, so the coexistence of several technological alternatives to the current benchmark may be desirable. This also reduces the risk of environmental sustainability problems when several sectors or applications depend on the same material.

The following sections give an overview of dependencies and substitution possibilities across the four strategic areas of energy, mobility, construction and electronics that were initially identified by the Communication on Advanced Materials for Industrial Leadership[58]. There is also the fifth area of health (medical devices, added in June 2025 by the Technology Council for Advanced Materials), and aerospace and defence, which are proposed to be added to the scope of the

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[53] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Advanced Materials for Industrial Leadership, COM(2024) 98 final.
[54] Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee: A strategic vision for European standards: Moving forward to enhance and accelerate the sustainable growth of the European economy by 2020, COM(2011) 311.
[55] COM(2026)780 final - Proposal for a Regulation on European standardisation, 6 October 2026.
[56] The SSbD framework can also be a guiding framework to steer the development of advanced materials.
[57] https://projectbeethoven.eu/.
[58] COM(2024) 98 final.

Advanced Materials for Europe agenda given the key role that advanced materials play for these important sectors (e.g. OCED, 2025).

Electronics

Electronics value chains depend on small-volume critical raw materials for functions such as semiconductors, capacitors, connectors, thermal substrates and infrared optics. Reducing the dependency on these materials requires a function-by-function approach. Alternatives already exist, but their reliability, scalability, recyclability, regulatory compliance and market acceptance must still be proven.

The study (European Commission 2026l) reviewed 74 material, design, process and circularity options for five materials: gallium, tantalum, palladium, beryllium/beryllium oxide and germanium. It concludes that the main need is to scale existing solutions from demonstration to deployment, rather than to discover entirely new materials, However, some development-stage research is still needed.

Examples of such concrete needs (and hence opportunities) are: using silicon-carbide as an alternative to gallium nitride, advancing new palladium-free termination chemistry to provide secure substrate supply and advanced packaging, and ceramic alternatives to beryllium oxide.

Energy

The energy sector relies strongly on the capabilities of certain critical raw materials in terms of miniaturisation, enhanced performance, and longevity. They are crucial for clean energy technologies, such as batteries, fuel cells and electrolysers, wind energy, electric vehicle motors and solar photovoltaics. The European Commission's Joint Research Centre (2025a) provides an overview of solutions using advanced materials to substitute and reduce critical and strategic raw materials in these five key clean energy technologies. It underlines that the maturity of these solutions varies across sectors and applications.

For instance, in batteries and electric vehicle motors, many innovative technologies that reduce or eliminate the use of critical raw materials (like cobalt, manganese and/or nickel) are already commercially available, although a reliance on lithium persists. As for wind energy, commercial technologies (such as induction generators) are viable for onshore wind applications, but less so for offshore applications, where emerging technologies such as high-temperature superconductors (as substitutes for rare-earth-based permanent magnets) are less mature. In the solar photovoltaics sector, many innovative technologies are still in the early commercialisation phase.

Solutions to reduce the dependency for hydrogen electrolysers and fuel cells could be available in the short term, however, solutions to completely substitute critical materials are in their very initial stage and are more likely to reach the commercial stage in the mid to long term.

Mobility

Value chains for passenger cars combine critical raw (and processed) material-intensive sensing, connector, structural, casting, thermal-management, and after-treatment functions. The study (European Commission 2026k) compares 97 advanced material, process, design and circularity routes across several portfolios: gallium and germanium in advanced driver-assistance systems sensing; palladium and beryllium in connectors and passive components; niobium in advanced high-strength steels; magnesium in lightweight castings; beryllium/beryllium oxide in power-electronics thermal management; and platinum-group metals in exhaust after-treatment. Analysing the potential reduction of critical raw materials, performance, reliability, cost, circularity and environmental sustainability considerations, it finds that across all seven portfolios, candidate substitute systems exist for most high-readiness functions. The recurring binding constraint is automotive qualification, pilot-line access and depth of the supplier-base.

Construction

The construction sector is becoming increasingly reliant on critical raw materials to meet sustainability targets and performance demands, especially due to the regulation of this area[59]. Certain materials – such as metals, plastics, chemicals, ceramics and glass – are more vulnerable due to their high dependence on critical raw materials. In contrast, commonly used materials like wood and cement-based products, such as concrete, are less dependent and therefore less affected by supply chain disruptions. Widely used materials include aluminium and copper. The production of steel uses for example manganese, silicon and niobium. Antimony is used as a flame retardant, and baryte is used in many plastic construction products. Others are platinum, rhodium, borates, titanium, cerium and cobalt.

The report (European Commission, 2026m) investigates the trade-offs for making substitutions in the areas of metals, plastics and chemicals, ceramics and glass. While elaborating on the opportunities, it also raises the fragmented nature of the construction sector as a challenge. Additionally, another recent study (European Commission, 2026c) points out that the construction sector is characterised by high liability concerns for contractors, who often default to using proven materials because the financial penalties for failure outweigh potential gains from innovation.

Health (medical devices)

Advanced materials are increasingly found as integral parts of medical devices. In the EU medical devices must undergo a conformity assessment to demonstrate that they meet legal requirements to ensure they are safe and perform as intended. Medical devices are regulated at EU level, and the national competent authorities of the Member States for medicinal products and the European Medicines Agency (EMA) are involved in the regulatory process[60].

Critical raw materials are used by a very wide range of medical devices. Examples include magnetic resonance imaging (MRI) scanners, X-ray detectors, ultrasound electronics, medical lasers, positron emission tomography (PET) detectors, pacemakers, implants, cancer brachytherapy and medical batteries. Critical raw materials on which these depend include rare earth elements, gallium, germanium, platinum, iridium, titanium, niobium, cobalt, copper and aluminium.

Medical devices also deployed as delivery mechanisms for many advanced medicines, such as advanced therapy medicinal products (ATMPs). These are medicines for human use that are based on gene therapies, somatic-cell therapies or tissue-engineered solutions. They offer groundbreaking new opportunities for the treatment of disease and injury[61].

Aerospace and defence

The EU's aerospace and defence industry has specific sectoral dependencies within aerospace and defence grade advanced materials from countries like China, US, Russia and Brazil. Except for Brazil, these countries pose considerable risks for export restrictions. This affects the EU aerospace and defence industry, for example in the case of the International Traffic in Arms Regulations (ITAR), with refined graphite being a case in point. This bears considerable risks for numerous advanced materials based on critical raw (and processed) materials. Stringent and long-term qualification and certification procedures to ensure product performance and safety make it more complicated for alternatives to enter the market. Due to urgencies coming from the worsening

[59] See in particular Regulation (EU) 2024/3110 laying down harmonised rules for the marketing of construction products.
[60] Regulation (EU) 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices, amending Directive 2001/83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and repealing Council Directives 90/385/EEC and 93/42/EEC, as amended by Regulation (EU) 2023/607 and Regulation (EU) 2024/1860.
[61] Regulation (EC) No 1394/2007 of the European Parliament and of the Council of 13 November 2007 on advanced therapy medicinal products and amending Directive 2001/83/EC and Regulation (EC) No 726/2004.

geopolitical situation and the principle of EU defence readiness, substitution is more difficult here, and building EU production capacities for existing advanced materials is a more suitable option.

The potential for reducing dependencies is also pointed out in the roadmap 'Destination 2050 – A Route to Net Zero European Aviation'[62], commissioned by major European aviation industry associations. The roadmap points out that R&D into critical raw material substitution, and better promoting innovation in advanced materials to increase global competitiveness should be supported.

The important role that advanced materials play is also illustrated by the European Monitor of Industrial Ecosystems (European Commission, 2025d), which shows that the aerospace and defence industrial ecosystem has the highest adoption rate of advanced materials (56%) for the green transition amongst the 12 industrial ecosystems. Only energy-intensive industries (33%), health (29%), textiles (29%) and agri-food (26%) also have adoption rates above 25%.

Advanced materials are strongly connected to strategic autonomy and EU defense readiness, as (1) they may be created using critical raw (and processed) materials, (2) the technology to create them may be monopolised by one country, (3) they may substitute and reduce the dependency on critical raw (and processed) materials or (4) export restrictions might hinder rapid production upscaling of the EU defense industry in case of materialising a military conflict. It is consequently crucial to map vulnerabilities, and to choose strategies such as substitution or circularity and incentivising the development of advanced materials to address these vulnerabilities.

3.8. Network initiatives

The EU's advanced materials ecosystem has various networks that form a basis for measures to further strengthen collaborations and align efforts.

The **M-ERA.NET**[63] network –European Research Area network (ERA-NET) for research and innovation on materials and battery technologies – brings together Member State funding agencies across Europe as well as funding agencies from third countries. This EU funded network was established to support and increase the coordination of research programmes and related funding in materials science and engineering. It has been supported through several grants under the framework programme since 2012. The third phase, M-ERA.NET 3, finished in August 2026, with 47 partners from 35 countries and 14 regions committing a total of EUR 215 million. The annual M-ERA.NET 3 calls typically received between 300 and 500 proposals and funded 35-70 projects. The leverage ratio (partner commitments divided by EU contribution, taking 2021 as a benchmark) is around 5. M-ERA.NET 4, which started in September 2026, has partners from 32 countries and will do three calls spread out over three years with a budget of EUR 150 million, as well as further joint activities, including knowledge valorisation. Apart from 23 EU Member States, several associated and non-associated countries are participating. These include associated countries, such as Norway, Canada, South Korea and Türkiye, but also others such as Brazil and South-Africa). M-ERA.NET complements European, national and regional funding schemes by funding small consortia that engage in risky, mid-TRL level research. It is attractive to early-stage researchers, researchers from widening countries and SMEs active in R&I.

The co-programmed European partnership on advanced materials called **'Innovative Advanced Materials for Europe (IAM4EU)'** is a key action launched under the Commission's 2024 advanced materials strategy. It brings researchers and industry closer to having the advanced materials technologies necessary to address today's challenges. The partnership focuses on

[62] https://www.destination2050.eu/
[63] https://www.m-era.net/.

accelerating the design, development and industrial uptake of safe and sustainable advanced materials and associated technologies fit for the circular economy. The Commission through Horizon Europe and the private partners plan to invest up to EUR 250 million each in this partnership by 2030. The non-profit association IAM-I[64] engaged in this partnership is a key voice for European advanced materials R&I, building a Europe-wide, cross-sector R&I ecosystem that accelerates the market uptake of sustainable advanced materials. Reaching over 300 members in 2026, it brings together stakeholders across the full materials value chain to support innovation for a digital and circular economy. This partnership built upon the **Advanced Materials 2030 Initiative** that released a Materials 2030 Manifesto[65] in February 2022. It was supported by several initiatives, such as EUMAT[66], SUSCHEM[67], EMIRI[68] and MANUFUTURE[69].

Many of the stakeholders of these communities have been brought together under IAM-I. This also includes those from the **Graphene Flagship**[70], which brings together 1125 academic and industrial partners in 13 research and innovation projects and one coordinating project. It is advancing Europe's strategic autonomy in technologies that rely on graphene and other 2D materials.

The **European Materials Modelling Council** (EMMC)[71] is an association of 50 organisational members covering different types of models, characterisation and digital representations for materials applied to chemicals and materials at all scales and applications.

The **Partnership for the Assessment of Risks from Chemicals** (PARC)[72] aims to develop next-generation chemical risk assessment to protect human health and the environment. It supports the European Union's chemicals strategy for sustainability and the European Green Deal's 'zero pollution' ambition with new data, knowledge, methods and tools, expertise and networks. This includes developing new approach methodologies (NAMs) that comprise non-animal testing strategies like in vitro methods (e.g. test tube biological experiments) and in silico and AI-supported approaches (i.e. computational modelling). This seven-year partnership has a total funding of EUR 400 million, of which 50% is funded by the European Union through Horizon Europe, and 50% by the Member States and associated countries. It brings together national and EU agencies for risk assessment and connects them to a network of research institutions.

In line with the objectives of the European Green Deal[73], **SSbD**[74] is a systemic approach to integrate safety, sustainability and functionality of products and processes throughout their life cycle, from design to end-of-life, with a view to reuse and recycling (circularity). It is proposed as an approach to R&I and product development that brings economic, environmental and social value for the benefit of society and business, supporting the ambitious goals of the strategy, including zero pollution for a toxic-free environment. The Commission Recommendation on the European assessment framework for SSbD[75], revised in March 2026, aims to promote a voluntary decision-making approach to guide innovation towards chemicals and materials that are safer and more sustainable over their whole life cycles.

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[64] https://www.iam-i.eu/.
[65] https://research-and-innovation.ec.europa.eu/document/download/fa1f3f35-7cac-49c7-a212-366879848f4c_en?filename=advanced-materials-2030-manifesto.pdf.
[66] https://eumat.eu/.
[67] https://cefic.org/science/suschem/.
[68] https://emiri.eu/home/.
[69] https://manufuture.org/.
[70] https://graphene-flagship.eu/.
[71] https://emmc.eu/.
[72] https://eu-parc.eu/.
[73] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[74] https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/chemicals-and-advanced-materials/safe-and-sustainable-design_en
[75] https://research-and-innovation.ec.europa.eu/document/download/b1ab09d8-d9ff-464b-a9af-3eae164799b5_en

The **EU Chemicals Innovation and Substitution Hubs** to be set up in the context of the European Chemicals Industry Action Plan will assist companies, particularly SMEs, in developing safer chemical alternatives, replacing hazardous substances like PFAS, and implementing the SSbD approach.

To promote the uptake of the SSbD approach, PARC and IAM-I are collaborating with the **Nano Safety Cluster (NSC) network** for safety and sustainability of chemicals[76], **IRISS**[77] and the international SSbD community. They intend to set up a platform allowing research consortia to connect and share tools, methods and experiences with implementing the SSbD framework. Each initiative come from a different angle: PARC brings the public risk assessment authorities, IAM4EU and IRISS the industrial perspective and NSC the large research community around nanosafety and sustainability. The research community also includes many civil society and social economy organisations.

A core element of IRISS is the active involvement of industry, engaging diverse value chains such as automotive, construction, electronics, energy, fragrance, packaging, and textiles. By connecting science, industry, and policy, IRISS provides a platform for co-creation and exchanging knowledge to drive sustainable transformation.

The EU-funded coordination action **InnoMatSyn**[78] supports the coordination of European, national and regional initiatives in the field of advanced materials towards a materials ecosystem that cover any type of advanced materials to accelerate the development and scale up of the materials. The initiative supports public authorities and research and innovation funding bodies by leveraging synergies between the different research communities, for example by working with M-ERA.NET. The project aims to create an AI-based repository tool for materials innovation knowledge that identifies possible needs and gaps. It will support national and regional funding agencies by providing recommendations and helping them to create joint calls. It also fosters an overarching, resilient European R&D&I ecosystem helping the different materials-related communities and funding agencies the cooperation with each other to monitor on-going research and generate new projects, and supports EU, national, and regional initiatives with risk assessment strategies on technology leakage.

The **Organisation for Economic Co-operation and Development** (**OECD)**[79] harmonises test methods, guidance, data formats and assessment approaches for assessing the safety and sustainability of new materials. More specifically, through its working party on manufactured nanomaterials, it develops internationally recognised test guidelines and approaches for evaluating the safety of chemicals and materials, providing authorities and companies with reliable ways of assessing hazards, exposure and risks. Such common standards, can reduce duplication of testing through mutual acceptance of data, making it easier for companies to operate across markets.

The **Malta Initiative**[80] is a voluntary network of representatives of European countries, several Directorates-General of the European Commission, the European Chemicals Agency (ECHA), authorities, research institutions, NGOs, universities and industry. It aims to find possibilities for developing and amending the measurement and test methods required to enforce legislation, with a focus on projects in which OECD test guidelines are amended or developed for nanoscale substances. In terms of skills and training actions and networks, advanced materials are also the

[76] https://nsc-community.eu/
[77] https://iriss-ssbd.eu/
[78] https://www.innomatsyn.eu/.
[79] https://www.oecd.org/.
[80] https://malta-initiative.org/.

topic of various **Marie-Skłodowska Curie networks** for doctoral education and postdoctoral training. Some examples are ASSESS[81], DurAMat[82] and Met2Adapt[83].

The ERDF supports a range of interregional cooperation initiatives that contribute to strengthening Europe's capacities in advanced materials. Under the **S3 Thematic Platforms**, ERDF provides technical support for creating partnerships such as Advanced Materials for Batteries for Electro-mobility and Stationary Energy Storage and New Nano-Enabled Products. These partnerships bring together regions with relevant RIS3 priorities to connect cross-border value chains, access new market opportunities, develop cutting-edge technologies and increase competitiveness. Furthermore, through the **Interregional Innovation Investments (I3) Instrument**, ERDF helps regions link their R&I ecosystems and align their value chains, turning territorial connectivity into interregional investments[84].

In addition, the European advanced materials ecosystem hosts many national and regional initiatives and organisations of business support networks, such as the Enterprise Europe Network and dedicated European **digital innovation hubs**[85] **and cluster organisations**[86]. At regional level, they group together specialised firms and related research institutions and help them collaborate with each other. This includes relevant EU-funded Euroclusters projects of the second generation, such as the **MAT4EU** on 'Advanced Materials for a Sustainable Europe Future'[87], which brings together advanced materials partners from France, Denmark, Germany, Lithuania, Spain and Poland to support innovation towards strategic autonomy and mastering the green and digital transformations. Other relevant Eurocluster projects are **BIONETZero** for 'Biosolutions for net-zero technologies for the agrifood and energy-intensive industry ecosystems' to reduce dependencies on critical raw materials with partners from Lithuania, German, Slovakia and Denmark, and the **JEWEL** 'Joint nEtWork for European net-zero manufacturing Leadership'[88], with partners from Belgium, Poland, Latvia, France, Finland and Italy.

The EU's advanced materials ecosystem has a large number of network initiatives that can be used to strengthen collaborations and align efforts. This includes the M-ERA.NET network of funding agencies, the European partnership on advanced materials (IAM4EU), the PARC Partnership on the risk assessment of chemicals, the Malta Initiative in relation to OECD test guidelines, the InnoMatSyn coordination action, networks of the SSbD community, and relevant Marie-Skłodowska Curie networks for doctoral education and postdoctoral training, interregional smart specialisation partnerships, Eurocluster projects and European digital innovation hubs.

4. EMERGING OPPORTUNITIES AND CHALLENGES IDENTIFIED

Building upon the description of the strength and weaknesses of the EU advanced materials ecosystem based on the studies presented so far, this section goes deeper into outlining the emerging opportunities and distinct challenges that the EU faces.

[81] https://www.assess-msca.eu/.
[82] https://duramat-project.eu/.
[83] https://www.met2adapt.eu/.
[84] In the field of advanced materials, a number of projects are supported through this instrument, including for example DeremCo (https://deremco.afil.it/), I4-GREEN (https://i3-i4green.eu/), Inkjet-BioAM (https://www.inkjetbioam.com/), EVEN-CLOSER (https://evencloser.eu/) and METIUM (https://metium.tuke.sk/).
[85] See the European Digital Innovation Hubs Network at https://european-digital-innovation-hubs.ec.europa.eu/.
[86] For a mapping of clusters by sectors, industrial ecosystem and countries, see the European Cluster Collaboration Platform at www.clustercollaboration.eu.
[87] www.clustercollaboration.eu/.
[88] For the BIONETZero and JEWEL projects see the same website.

4.1. Responding to a growing demand

As concluded in a foresight study (European Commission, 2023a) and the European Commission's strategy[89], the **demand for advanced materials is expected to significantly increase in the coming years**. This offers emerging opportunities for European businesses and researchers alike, for instance for the production of wind energy[90], solar panels, sustainable batteries[91], zero-emission buildings[92], semiconductors[93], construction (see European Commission, 2026c), mobility (see European Commission, 2026f), aviation[94], medicines and medical devices, satellites, space launchers, and for other dual-use applications as well as defence equipment.

It is not only Europe that is expecting this increase. It is expected across the world and other countries such as China, the US, Japan and South Korea are equally prioritising advanced materials to meet future demands.

As discussed in the previous section, the EU has demonstrated its strong resilience in the face of global challenges. It has made real progress in advancing its green and digital transitions while upholding its social model. Despite these solid efforts, its global position in terms of innovation is challenged by growing and fierce competition. As noted by Mario Draghi (2025) in his report on '[t]he future of European competitiveness', Europe is lagging behind key global competitors in both innovation and productivity, which are key drivers of long-term economic growth and are critical to preserving the EU's strategic autonomy. To close the innovation gap, he called for boosting European excellence in research and innovation building on the Commission's 2024 strategy for industrial leadership in advanced materials and ensuring that EU funds effectively reinforce and steer investment in technology development and deployment.

The need for advanced materials is not only about meeting the growing demand, but also a consequence of various policy objectives[95] which for example gave rise to the Net-Zero Industry Act[96], and the strategic energy technology (SET) plan. The expected increase in demand for advanced materials is thus not only a **foreseeable consequence of policy choices**, it is also widely **acknowledged in industry**. This is also reflected in the replies by stakeholders to the public consultation. For instance, 93% of respondents expect a high or very high demand in sustainability mobility, 92% in renewable and low-carbon energy, 85% in sustainable electronics and 81% for aerospace and defence.

Moreover, the Global Resources Outlook of the United Nations Environment Programme (2024) reports that **global demand for raw materials has more than tripled over the past five decades**, driven by urbanisation, technological progress, rising incomes, population growth and shorter product lifespans. There is hence a strong incentive to ensure the availability of materials and their substitutes. Between 1970 and 2020, global material extraction rose from approximately 30 billion tonnes to over 95 billion tonnes. Without significant intervention, it is projected to increase by another 60% by 2060, potentially reaching 160 billion tonnes annually.

The previous sections illustrate why Europe face a **challenge to meet this rising demand**. This raises concerns about potential major consequences in case it fails to act: the EU may face difficulties in achieving its policy objectives in the different sectors; it may lose its technological

[89] COM(2024) 98 final.
[90] European Wind Power Action Plan, COM(2023) 669 final.
[91] https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en.
[92] https://www.consilium.europa.eu/en/press/press-releases/2023/12/07/fit-for-55-council-and-parliament-reach-deal-on-proposal-to-revise-energy-performance-of-buildings-directive/ .
[93] Chips Act (EU) 2021/694.
[94] https://www.destination2050.eu/.
[95] See for example COM(2023) 62 final 'A Green Deal Industrial Plan for the Net-Zero Age'.
[96] Regulation (EU) 2024/1735 of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724.

leadership role, and this could lead to a rapidly increasing number of dependencies on third countries; and it may fall behind its current industrial competitiveness position, leading to job losses.

When looking at the pool of industrial users, a study on production and use of advanced materials (European Commission, 2026e) finds that the share of products integrating advanced materials as a proportion of the total product portfolio varies across countries, with the US leading the way at 50%, followed by the Japan, South Korea and the UK at around 40%, while the EU trails behind at around 30%. The trade balance for advanced materials with China has deteriorated, dropping to a deficit of around one billion euro per year in 2023 and 2024.

The same study also concludes that the **share of products that depend on advanced materials is expected to increase significantly** over the next five years, reflecting the strategic importance of these technologies for competitiveness, sustainability and resilience. Not only do they have a systemic role in our economy; many jobs are also dependent on advanced materials. In the 100 companies sampled in the study, an average of 28% of employees depend in their work on advanced materials. This is despite the same companies raising concerns about various barriers that exist in Europe, such as delays in permitting and approval (over 60% of supply side companies), compliance with safety regulation (REACH) and substance registration (almost 60% of supply-side companies), but also the initial investment hurdle (80%). A lack of demand, on the other hand, is an issue for only 20% of these companies.

Addressing **structural challenges** – such as bottlenecks in value chains, alignment between regulatory-driven demand and industrial supply readiness, and fragmentation of the R&I ecosystem – will be critical in ensuring that sustainability-driven uptake translates into durable economic value and industrial competitiveness. This would allow the EU to grasp opportunities from the growing demand and to match or exceed the performance of leading non-EU regions.

The following three sections further analyse the core reason why Europe is challenged and trails behind in the uptake of advanced materials, separated into the following *three main challenges*:

1. value chain dependencies,
2. the gap between innovation and deployments, and
3. a fragmented R&I ecosystem for advanced materials.

The EU policy agenda needs to respond to global challenges by adapting to a more focused competitiveness strategy. This reorientation should prioritise targeted investments and innovation in specific technological domains where Europe must excel to secure its long-term economic resilience, strategic autonomy and global influence. At the same time, these challenges represent opportunities: if they can be successfully mastered, the potential efficiency gains and positive impact on the competitiveness of the European advanced materials ecosystem could be significant.

4.2. Value chain dependencies

As described in the previous section, **Europe lacks mechanisms that ensure sufficient production capacity for advanced materials** that play a key role in various sectors. These **supply chain dependencies** undermine Europe's strategic autonomy and pose the threat of price volatility. Examples of crucial dependencies for European economy and defence include advanced composites, rare earth magnets, high-performance polymers, gallium nitride and silicon carbide, advanced ceramics and high-strength alloys. Sectors affected include, in particular, automotive, aerospace, renewable and clean energy technologies, defence and healthcare. For example, while the market for rare earth magnets itself is relatively small – about EUR 6.5 billion – its downstream leverage is enormous: the mobility business in the EU alone is expected to grow to about EUR 500 billion by 2030, with 6 million jobs (see Gauß et al., 2021).

Compared to other regions of the world, particularly the China and the US, the **EU's advanced materials production ecosystems are more fragmented and less vertically integrated**, limiting coordinated scale-up and industrial resilience. Expansion of production capacity is constrained by high capital intensity, long investment and permitting cycles, regulatory complexity and dependencies on key non-EU steps of the value chain.

On the demand side, **infrastructure readiness, skills availability and access to finance emerged as key limiting factors**, with SMEs disproportionately affected. As a result, Europe faces a structural risk of stimulating demand for advanced materials without fully capturing the associated industrial, economic and strategic benefits within the EU (European Commission, 2026e).

While **the EU performs well in high-value specialised advanced materials**, which contributes to a positive trade balance in terms of value (in euro), it remains **less competitive in mass-production segments and in materials linked to critical raw material dependencies**, which leads to a trade volume deficit (in tonnes). Similarly, EU production capacity has lagged behind its utilisation capacity for the past decade, highlighting structural gaps where imports are needed to meet this industrial demand, especially for classes where large-scale manufacturing is required (European Commission, 2026e).

Concentrated supply chains were the obstacle most frequently cited by the advanced materials companies consulted, with over 68% of respondents considering them one of the top obstacles to be overcome to ensure the availability of advanced materials for a clean and competitive industry (European Commission, 2026e). The contributions revealed the multifaceted nature of these dependencies, such as the high reliance on non-EU suppliers for critical raw material precursors needed to produce advanced materials, intermediate products and processing capacities, export restrictions and state-supported competition from third countries. For these vulnerable segments of the advanced materials value chain, EU companies are exposed both to supply disruptions in terms of quantities and to potentially high volatilities in terms of prices, especially when operating in the position of a price-taker.

Companies interviewed for the study (European Commission, 2026e) also highlighted dependencies linked to upstream processing stages, including refining, purification and intermediate processing of critical raw materials into advanced material inputs. These dependencies are particularly pronounced in material classes requiring energy-intensive processing or continuous large-volume production, where EU industrial capacity remains limited and less aligned with the current production structure dominated by specialised SMEs.

For instance, in the context of energy transition, battery energy storage systems (BESSs for short) and hydrogen storage solutions are essential for integrating intermittent renewables, such as wind and solar energy, into the energy grid. They provide the flexibility needed to balance supply and demand, stabilise the grid, and ensure a continuous, reliable energy supply (European Commission, 2025a). By storing excess energy generated during periods of high production and releasing it when needed, BESS and hydrogen storage solutions maximise the utilisation of renewable resources, reduce dependency on fossil fuels and support the EU's decarbonisation goals.

4.3. Advanced materials innovation deployment gap

Bridging the gap between EU research and innovation outputs, on the one hand, and their uptake in production applications, on the other, is a key condition for fostering and safeguarding the advanced materials value chain in the EU.

As described in Section 3, the high global ranking of EU scientific publications is not translated in terms of the number of patents or patent families, especially in view of the rapid patenting growth of China, and only a small percentage of advanced material company patents have a priority filing in the EU.

European universities, research organisations and companies face **interconnected financial, organisational and regulatory barriers to patenting and commercialising advanced materials.** High patenting costs, limited expertise, slow examination processes and jurisdictional complexities introduce uncertainty and delays, showing the need for simplification. **Sector-specific challenges** – such as the capital-intensive nature of material qualification, scale-up difficulties, and multidisciplinary demands – further amplify the risks. Additionally, a weak patent culture, insufficient IP training and a lack of academic incentives to pursue commercialisation hinder the exploitation of research outcomes.

The study of the production and use of advanced materials (European Commission, 2026e) also raises issues that show a disconnect between research and industrial innovation, describing how **gaps exist in conformity testing, certification and regulatory support, especially in application-driven and safety-critical sectors**, such as hydrogen technologies, medical applications, construction and advanced electronics. These lead to higher costs, longer time-to-market periods and increased dependence on non-EU facilities, also underlining the need for simplification.

Similar concerns are identified in a study of infrastructures for advanced materials (European Commission, 2026a). With regard to **structural gaps that constrain the capacity of advanced material research and technology infrastructures to support innovation** from early research to industrial deployment, the study found:

- limited availability and visibility of pilot-scale and pre-commercial production facilities across sectors (e.g. only 25% offer reduced access fees for SMEs, start-ups or specific user groups);
- fragmented efforts on digitalisation and AI capacity building (only 3% of the surveyed infrastructures have a focus on digitalisation);
- gaps in conformity testing, certification and regulatory support, particularly in application-driven and safety-critical sectors;
- system-level gaps persist in value chain integration and coordination (for example, only 30% of the surveyed infrastructures offer services against a fee).

When asked about the reasons for the innovation deployment gap, almost 90% of the respondents to the open public consultation saw investing in technology infrastructure as effective or very effective. They also noted that the regulatory burden is relatively higher than in countries outside the EU. Business respondents, in particular, ranked this barrier the highest (66%). Similar concerns were raised in the call for evidence. The EU's regulatory environment was perceived as complex, fragmented and too slow, with hurdles in material qualification, certification and permitting procedures, lack of harmonised standards and test methods, and divergent national approaches. The availability of a skilled workforce, enabling industry to deploy new technologies, was also raised as a major hurdle to accelerating the deployment and scaling-up of advanced materials.

During the reality check workshop on advanced materials organised on 24 March 2026, stakeholders pointed out, for instance, that **registering novel materials** under the REACH Regulation can be time-consuming and expensive. They also pointed to the costs of certification against certain standards. These costs can be a major barrier, especially for SMEs, and are particularly significant in sectors with high safety standards (e.g. aerospace).

4.4. Fragmented advanced materials R&I ecosystem

The EU has a strong advanced materials R&I ecosystem. However, it is fragmented and suffers from a disconnect between research and innovation, with insufficient continuity between research, technology transfer, subsequent material qualification for industrial applications and market uptake. This is reflected in the patent landscape, in the usage of RIs and TIs, in the available interoperable data and digital tools and platforms, and also more generally in the uptake of advanced materials innovation.

Cross-border cooperation of advanced material RIs and TIs and industrial access remain limited, as they are hindered by fragmented funding landscapes, administrative complexity and limited visibility, particularly affecting SMEs. The study on the role of European RIs and TIs for advanced materials uptake (European Commission, 2026a) also reports on constraints because of State aid[97] and concludes that the current advanced materials landscape is highly fragmented and dominated by organisation-level inventories, with fewer national examples and very limited sustainable EU-level examples.

Industry-academia cooperation needs to be better aligned with **valorisation** objectives, as differing incentives and fragmented institutional practices limit the translation into jointly exploited IP. In fields relating to advanced materials – where technological developments span multiple domains and intellectual property is often fragmented over a wide range of actors – mechanisms are needed to overcome barriers to technology valorisation, such as high transaction costs, access to complementary technologies and lack of diffusion of intellectual property.

When it comes to **digitalisation**, which was raised as one of the key challenges in Section 3.3, the situation is similar. Major initiatives on the use of data, digital tools and artificial intelligence have been launched, for example, in Japan[98], in the US as part of the Genesis Mission[99] and in Canada[100]. Only a few countries in Europe have a national initiative of this type (MaterialDigital in Germany[101], PEPR DIADEM in France[102] and the CAPeX Pioneer Center in Denmark[103]), which only now are being brought together in a common effort through the EU-funded Materials Commons project[104], in collaboration with efforts being made in Switzerland and the UK. Stakeholders also point to gaps in the access to data, AI-enabled tools, interoperable digital R&I infrastructures and digital links to regulatory frameworks. Digitalisation is perceived as an enabling condition to speed up discovery, material qualification and regulatory preparedness in the entire advanced materials value chain[105]. The move towards self-driving labs also poses a challenge to Europe, as they require large investments and extensive know-how, which requires cross-border cooperation.

An article on **regulatory preparedness for advanced materials** (Schwirn et al., 2025), for instance, concludes that, to ensure safe innovation, several measures need to be undertaken. These include, in particular, proper funding of regulatory-relevant safety research to identify and close knowledge and methodological gaps, and the development of progressive testing and assessment strategies, while resolving legal gaps and removing uncertainty. The article also points to complexity in dealing with advanced materials in terms of whether they ought to be considered as substances, mixtures or articles and the regulatory challenges this poses for emerging technologies, such as nanotechnology.

This issue of **fragmentation of the R&I ecosystem** is also reflected in the replies from the open public consultation and the call for evidence. Stakeholders indicated that fragmentation across materials design, processing and manufacturing is one of the reasons why innovation cycles are relatively slower in the EU. Fragmentation affects the link between academia and industry, with 52% of replies indicating that the challenge is not so much the lack of research activities, but rather the missing link between academic research and industry needs. There is insufficient continuity between research, technology transfer, subsequent material qualification for industrial applications

[97] The revision of the General Block Exemption Regulation (GBER) that will enter into force in 2027 will streamline rules applicable to RIs and TIs.
[98] https://dxmt.nims.go.jp/en/about.
[99] https://genesis.energy.gov/.
[100] https://acceleration.utoronto.ca/.
[101] https://www.materialdigital.de/.
[102] https://www.pepr-diadem.fr/en/.
[103] https://dg.dk/en/centers/pioneer-center-for-accelerating-p2x-materials-discovery-capex/.
[104] https://materialscommons4.eu/.
[105] See annex regarding call for evidence and open public consultation.

and market uptake. The fragmentation also extends to the capacity and enabling conditions, with over 45% of respondents having identified the lack of production capacity as a main bottleneck, with more than 40% identifying the lack of testing and experimenting facilities for advanced materials. Overall, the advanced materials research and innovation ecosystem was described as "rich in capabilities but highly fragmented"[106].

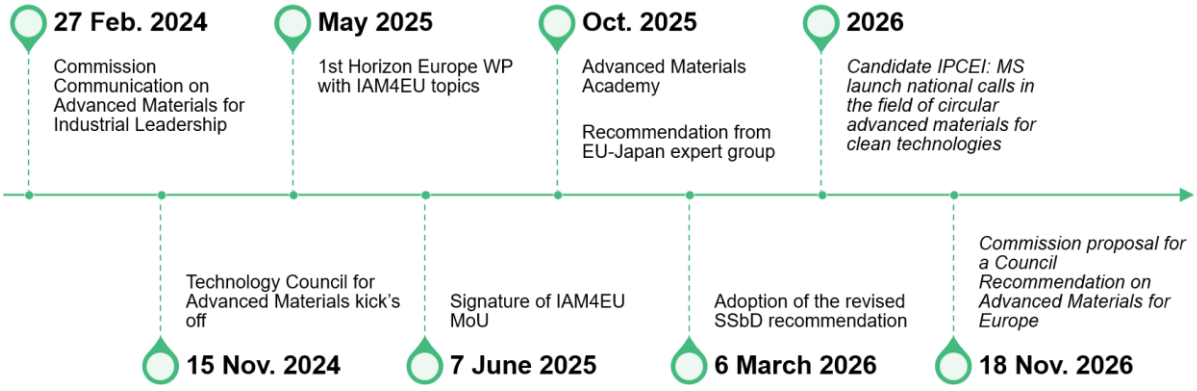
5. EXISTING POLICY FRAMEWORK

5.1. European regulatory and policy landscape

The regulatory and policy landscape for advanced materials touches on **various legislative frameworks and strategies**.

A central policy document is the **2024 strategy** entitled 'Advanced Materials for Industrial Leadership'[107]. The proposed Council Recommendation on Advanced Materials for Europe can build on progress achieved by several of the actions announced towards a strong European ecosystem for advanced materials, which have since been or are being implemented (see Figure 6 below).

Figure 6. Overview of initiatives from the 'Advanced Materials for Industrial Leadership' strategy



This includes, for instance, the set-up of the Technology Council for Advanced Materials[108], as a governance structure, which brings together Member States, industry and academia to align R&I efforts and priorities in the field, and the launch of the European Advanced Materials Academy[109], which aims to train 200 000 students and workers by 2029 in order to boost skills. It also comprises the launch in June 2026 of the pilot project for a digital R&I infrastructure, called the 'Materials Commons', which brings together data hubs to provide advanced digital tools for materials discovery and development to researchers and industries.

The actions taken also comprises the launch of a new co-programmed Horizon Europe partnership Innovative Advanced Materials for Europe (IAM4EU)[110], with EUR 500 million of public and private funding planned until 2030. The Horizon Europe work programme had its first dedicated

[106] See annex for details of these consultations.
[107] COM(2024) 98 final.
[108] https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/technology-council-advanced-materials-holds-inaugural-meeting-2024-11-18_en.
[109] https://eitrawmaterials.eu/education-skills/european-advanced-materials-academy.
[110] https://www.iam-i.eu/.

calls with IAM4EU topics in 2025. In addition, as already highlighted in Section 3.8 on network initiatives, Member States have cooperated since 2012 through an ERA-Net project[111]. Member States are also preparing an Important Project of Common European Interest (IPCEI) on circular advanced materials, which focuses on developing recyclable, sustainable advanced materials in the priority areas of renewable energy sources, industrial decarbonisation, and clean mobility[112].

Sectoral policies

An important related regulation is the Critical Raw Materials Act[113], which addresses, amongst other things, the need for R&I in supporting the development of substitutions for critical raw materials. This is highly relevant to the Advanced Materials for Europe agenda of the proposed Council Recommendation on Advanced Materials, given the potential of advanced materials to substitute for – or reduce dependency on – critical raw materials. For this reason, several projects recognised as strategic projects under the Critical Raw Materials Act focus on advanced materials (e.g. on lithium-free batteries, cobalt-free cathodes and rare earth element-free magnets). Additionally, the European Union funds the Raw Materials Partnership for the Green and Digital Transition (RAMP), a global partnership for enabling transnational research and innovation funding across the raw materials value chain[114].

The Net-Zero Industry Act[115] aims to strengthen Europe's position in the manufacturing of net-zero clean technologies and to increase its resilience. Some of the strategic projects launched under this Act are also closely linked to advanced materials (e.g. perovskites for solar panels, blades for wind energy, graphene supercapacitors, superconductors for grid technologies). Moreover, the Act enshrined a Steering Group for the Strategic Energy Technology Plan (SET Plan)[116], for which advanced materials are equally crucial.

The proposed Industrial Accelerator Act[117] builds on the Commission's communication on the Clean Industrial Deal and aims to address the EU's dependencies on trading partners in strategic sectors that put the EU's security, competitiveness and economy at risk, as highlighted in the Draghi report on European competitiveness. The proposal introduces measures on lead markets for low-carbon and Union-origin industrial products as well as industrial manufacturing acceleration areas, both relevant for advanced materials.

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[111] See https://www.m-era.net/. This was described in Section 3.8.
[112] Under the candidate IPCEI for circular advanced materials, calls for expressions of interests were launched by several Member States.
[113] Regulation (EU) 2024/1252 of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020.
[114] See https://ramprawmaterials.eu/.
[115] Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724.
[116] European Commission, SET Plan Information System (SETIS), available at: https://setis.ec.europa.eu/.
[117] Commission Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures for the acceleration of industrial capacity and decarbonisation in strategic sectors and amending Regulations (EU) 2018/1724, (EU) 2024/1735 and (EU) 2024/3110, COM(2026) 100 final, 4.3.2026.

Other relevant regulations are, the Chips Act[118] and the proposed Chips Act 2.0[119], the planned EU Quantum Act[120], the proposed Biotech Act (I)[121] for health and the planned Biotech Act II[122] for biomanufacturing, where advanced materials are important to achieve the objectives of the Act, the Waste Framework Directive[123] and the planned Circular Economy Act[124]. Other examples of relevant initiatives and strategies are the above mentioned voluntary European assessment framework for 'safe and sustainable by design' chemicals and materials[125], the Chemicals Industry Action Plan[126], the Bioeconomy strategy[127] and the Strategy for European Life Sciences[128].

In addition to these sectoral policies and regulations, the European regulatory landscape also comprises the framework for regulating chemicals and materials in terms of risks to human health and the environment. This includes the REACH Regulation[129], in force since 2007, with later amendments having introduced nano-specific clarifications and provisions[130] – including on safety data sheets –, and the separate CLP (Classification, Labelling and Packaging) Regulation[131]. Additional sectoral standards and legislation exist, for instance, for construction products[132], medical devices[133], cosmetics[134] and plant protection products[135]. Moreover, products are subject to the Ecodesign for Sustainable Products Regulation (ESPR)[136], which includes the roll-out of the

[118] Regulation (EU) 2023/1781 of the European Parliament and of the Council establishing a framework of measures for strengthening Europe's semiconductor ecosystem and amending Regulation (EU) 2021/694 (Chips Act).
[119] Proposal for a Regulation of the European Parliament and of the Council on a framework of measures for strengthening the Union's semiconductor ecosystem, repealing Regulation (EU) 2023/1781 (Chips Act 2.0), COM(2026) 504 final, 3.6.2026.
[120] https://digital-strategy.ec.europa.eu/en/news/commission-invites-contributions-shape-future-eu-quantum-act.
[121] Proposal for a Regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Union's biotechnology and biomanufacturing sectors particularly in the area of health and amending Regulations (EC) No 178/2002, (EC) No 1394/2007, (EU) No 536/2014, (EU) 2019/6, (EU) 2024/795 and (EU) 2024/1938 (European Biotech Act), COM(2025) 1022 final/2, 16.12.2025.
[122] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/17394-Biotech-Act-II_en.
[123] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.
[124] https://environment.ec.europa.eu/strategy/circular-economy_en#circular-economy-act.
[125] https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/european-ai-science-strategy/raise-resource-ai-science-europe_en
[126] European Commission, A European Chemicals Industry Action Plan, COM(2025) 530 final, 8.7.2025.
[127] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Strategic Framework for a Competitive and Sustainable EU Bioeconomy, COM/2025/960 final, 27.11.2025.
[128] https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/jobs-and-economy/strategy-european-life-sciences_en
[129] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.
[130] Commission Regulation (EU) 2018/1881 and (EU) 2020/878.
[131] Regulation (EU) 2024/2865 of the European Parliament and of the Council of 23 October 2024 amending Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures.
[132] Regulation (EU) 2024/3110 of the European Parliament and of the Council of 27 November 2024 laying down harmonised rules for the marketing of construction products and repealing Regulation (EU) No 305/2011.
[133] Regulation (EU) 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices, amending Directive 2001/83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and repealing Council Directives 90/385/EEC and 93/42/EEC.
[134] Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products.
[135] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC.
[136] Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC.

digital product passport[137] which in February 2027 will become mandatory for certain types of batteries, including electric vehicles, light means of transport and industrial batteries, for example.

General R&I and economic policies

The Commission has proposed the European Innovation Act[138] and is planning several related legislative initiatives, such as the European Research Area Act, that address uneven R&D investment and pre-commercial and innovation procurement. It has also proposed a Council Recommendation on common principles for regulatory sandboxes[139].

Existing policies include the Global Gateway[140], the Strategic Technologies for Europe Platform (STEP)[141], the EU Startup and Scaleup Strategy[142], the Commission Recommendation on critical technology areas for the EU's economic security[143], the RESsourceEU Action Plan[144], the AI Continent Action Plan[145] and the AI in Science Strategy, the Cloud and AI Development Act, the Data Act[146], the Quantum Europe Strategy[147], the European Strategy on Research and Technology Infrastructures[148] and the Union of Skills[149].

[137] https://single-market-economy.ec.europa.eu/single-market/digital-product-passport_en.
[138] Commission Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures for strengthening the Union innovation ecosystem and amending Regulation (EU) 2017/1001 (European Innovation Act), COM(2026) 567, 9.9.2026.
[139] Proposal for a Council Recommendation on common principles on regulatory sandboxes to support innovation and a future-proof regulatory framework, COM(2026) 568 final, 9.9.2026.
[140] https://commission.europa.eu/topics/international-partnerships/global-gateway_en.
[141] https://strategic-technologies.europa.eu/index_en.
[142] https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/jobs-and-economy/eu-startup-and-scaleup-strategy_en.
[143] Commission Recommendation (EU) 2023/2113 on critical technology areas for the EU's economic security for further risk assessment with Member States.
[144] https://transition-pathways.europa.eu/retail/policy/resourceeu-action-plan-accelerating-our-critical-raw-materials-strategy-adapt-new.
[145] https://digital-strategy.ec.europa.eu/en/library/ai-continent-action-plan.
[146] Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act).
[147] Communication from the Commission to the European Parliament and the Council, Quantum Europe Strategy: Quantum Europe in a Changing World, COM(2025) 363 final, 2.7.2025.
[148] https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/european-strategy-research-and-technology-infrastructures_en.
[149] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, The Union of Skills, COM(2025) 90 final, 5.3.2025.

Figure 7. Overview of regulatory frameworks and policy initiatives

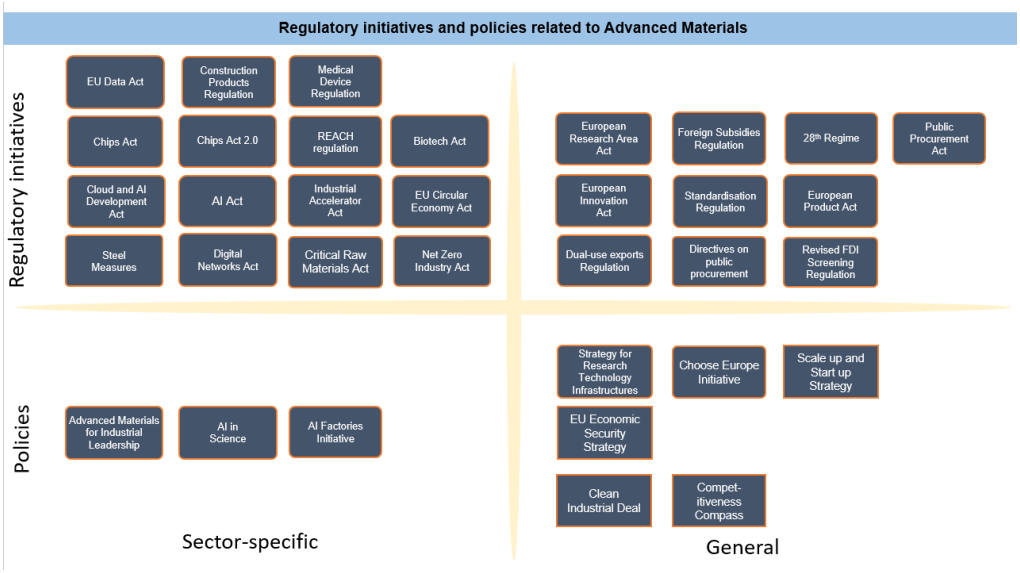


Figure 7 provides an illustrative and non-exhaustive overview of the main regulatory frameworks and policy initiatives that are relevant to advanced materials.

The transition to the next multiannual financial framework (MFF) for 2028-2034 may offer **new opportunities to support the deployment and scale-up** as it is intended to boost competitiveness to help Europe secure supply chains, scale up innovation and lead the global race in clean and smart technologies. The new European Competitiveness Fund and the next Horizon Europe programme will invest in strategic technologies and focus support in different areas. They are expected to cover the entire innovation-to-investment journey.

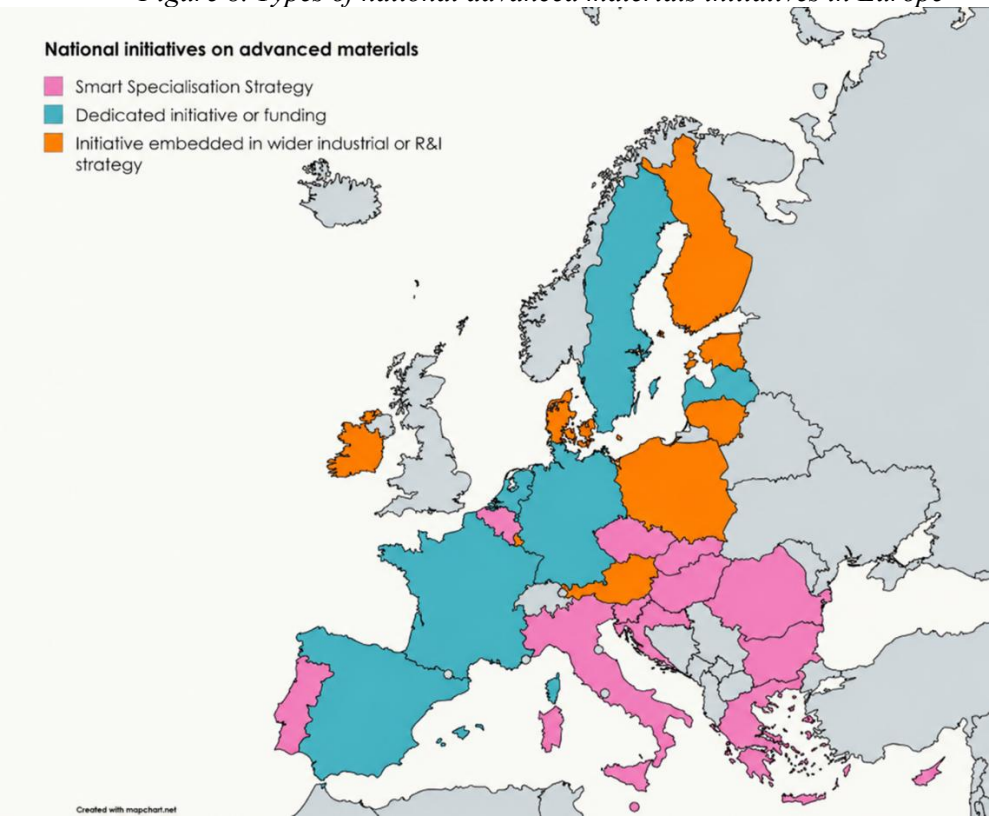
A key element that the Advanced Materials for Europe agenda of the proposal for a Council Recommendation on Advanced Materials brings is the connection between R&I value chains and innovations across several sectors, building on synergies with existing measures under the Acts mentioned above. The proposed agenda, for instance, can benefit from the tools and instruments already in place, such as strategic projects that could be launched in accordance with the Critical Raw Materials Act and the Net-Zero Industry Act.

5.2. National and regional policies

Member States address advanced materials in different ways. An analysis of national and regional policies is helpful to identify patterns across strategies, road maps and programmes.

Figure 8 provides an overview of the **different ways in which EU Member States pursue national initiatives on advanced materials**. It shows that there are some Member States with a dedicated initiative or funding, some that embed advanced materials in a wider industrial or R&I strategy, and a third group that use a smart specialisation strategy in which materials feature as one priority among others.

Figure 8. Types of national advanced materials initiatives in Europe



The majority of Member States do not yet have a dedicated advanced materials strategy. Some Member States (e.g. Germany, Netherlands, Sweden) have published strategies or policy documents which explicitly refer to the area of advanced materials, setting policy objectives with their own budget lines, governance bodies and road maps, while others treat it as a subcategory within broader terms like 'advanced manufacturing', 'functional materials', 'new production processes' or 'key enabling technologies'.

Annex 3 provides a concise summary of the key features of the Member States' relevant advanced materials programmes, as they are at June 2026. It should be noted that this policy field is constantly evolving, so there is risk of missing new developments or programmes, strategies and policies that are relevant to advanced materials but are encompassed in wider policy settings.

From the description of national approaches, a few **common patterns** can be identified:

- In most cases, advanced materials are not governed through a dedicated national strategy. More often, they are included within broader frameworks such as industrial policy, research and innovation strategies, smart specialisation strategies, key enabling technologies, advanced manufacturing or circular economy policies.
- Policies often treat advanced materials as a cross-cutting field linked to wider national priorities, rather than as an isolated sector, connecting it to transitions in energy, mobility, health, construction, manufacturing, sustainability and digitalisation.
- Smart specialisation strategies (S3/RIS3) or similar national and/or regional innovation planning tools are often used, where materials appear as one priority area among others.

More generally speaking, many countries rely on existing research funds, innovation programmes, competence centres, public-private partnerships and innovation agencies.

- Although countries rely on research funds and innovation programmes, this is generally not connected to industrial policy, showing another dimension of the deployment gap identified in the previous section.
- Advanced materials are often connected to critical raw materials, batteries, semiconductors, circularity, resource efficiency and industrial resilience, reflecting broader sustainability and strategic sovereignty objectives.

In addition to national and regional activities, many of the Member State funding agencies come together in M.ERA-NET, an ERA-NET for research and innovation on materials and battery technologies (see description in Section 3.8 on network initiatives).

5.3. Policies in other global regions

To understand how the EU positions itself globally in the field of advanced materials, it is useful to compare policy approaches across major regions and to examine the rationale behind them. While these policies respond to specific domestic contexts, they also reveal broader global trends and highlight the relative strengths of different regional research, innovation and industrial ecosystems[150].

To put the approaches taken in other regions into context, the study (OECD, 2025a) analyses strategies to strengthen leadership in advanced materials across the globe. Data used for this study comprises national advanced materials strategies, as well as anticipatory processes that inform those strategies, and case studies.

Policy focus on advanced materials in other global regions

In the Asia-Pacific region, Japan remains a global leader in advanced materials, driven by its Materials Innovation Strategy[151], which seeks to revitalise its materials industry through data-driven R&D and circular economy principles. The strategy is part of Japan's broader Society 5.0 vision of a hyper-connected sustainable society enabled by advanced technologies. A central element of this strategy is the Materials DX Platform Project of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), which aims to implement digital transformation in materials research throughout Japan. This process began around 2015, and the current nine-year project, launched in April 2022, aims to develop new functional and other materials. Pioneering data-driven research methods that are completely different from conventional methods will be developed for innovations in materials research.

Japan engages with the EU in an Enhanced Dialogue on Advanced Materials, which was launched in 2024. As part of that dialogue, an expert recommendation was published in October 2025 ('Expert Group under the EU-Japan Enhanced Dialogue on Advanced Material Recommendation')[152]. The expert group focused on five key domains: construction, energy, mobility, electronics, and data-driven R&D (including autonomous experimental systems), addressing critical needs, complementarities, and opportunities for cooperation.

Similarly, China recognised the importance of advanced materials and made it a national priority under its 15th Five-Year Plan[153] (covering the period 2026-2030), as part of its push for self-

[150] As long ago as in 1982, the economic importance of advanced materials was reflected in the creation by the G7 and the Commission of the Versailles Project on Advanced Materials and Standards (VAMAS – https://vamas.org).
[151] material_2025_honbun.pdf.
[152] https://www8.cao.go.jp/cstp/material/eu/expertadvice2025.pdf.
[153] https://www.news.cn/politics/20260313/085af5de5a4b4268aa7d87d90817df2f/c.html.

reliance in critical technologies and the advancement of high-tech industries, with a focus on specialty steel, high-temperature alloys, ultra-high-purity metals, advanced ceramics, high-purity silica, bio-materials, advanced polymer materials, high-performance fibres and multifunctional composites. Major state investments are therefore to be expected (including in a new materials big data centre by 2035), while China already dominates in graphene and high-strength alloys, using its control over the majority of global rare earth supplies to strengthen its geopolitical and economic influence. The Made in China 2025 initiative already aimed for self-sufficiency in advanced materials for robotics, aerospace and electric vehicles (EVs). As discussed in Section 3, China has become a major player in the area of advanced materials, in particular those which are produced and sold in high volume.

South Korea is another important actor in the region. Its strategy focuses strongly on semiconductor materials, displays and battery technologies, supported by the National Strategic Technology Nurture Plan. Its 2024 national strategy sets out a road map to develop 100 materials within five years, with particular emphasis on resilience and industrial competitiveness.

In North America, the United States has made advanced materials a cornerstone of its industrial, technological and defence strategies. The US National Strategy for Advanced Manufacturing[154] explicitly prioritises materials that are critical to semiconductors, clean energy and defence applications. This is in keeping with broader efforts to reduce dependence on foreign supply chains and secure access to critical minerals, including rare earth elements. In addition, the US Defense Advanced Research Projects Agency (DARPA) supports dedicated programmes in materials science, including engineered living materials, lightweight and high-strength materials, phase-change materials, quantum materials and additive manufacturing. Advanced materials also fall under the Genesis Mission, a national initiative to build the world's most powerful scientific platform to accelerate discovery science, strengthen national security and drive energy innovation.

Meanwhile, Canada has taken a more regional approach, with PRIMA Quebec's 2035 Advanced Materials Roadmap[155] focusing on decarbonisation, circular supply chains and the growth of SMEs. The road map emphasises industry-research collaboration to position Quebec as a leader in sustainable materials innovation, particularly for aerospace, energy and digital manufacturing. One initiative in Canada that stands out is the Accelerator Consortium[156], a leading initiative in the area of self-driving labs (see also Sections 3.2 and 3.3) that create new materials in a smarter way at a fraction of the usual time and cost.

The United Kingdom has also developed a long-term approach through its 2025 National Materials Innovation Strategy, which sets out a 10-year vision for strengthening the UK's materials ecosystem. This strategy places emphasis on coordination, industrial uptake and the role of materials innovation in supporting wider economic and technological priorities.

Global investment levels

Investment levels further illustrate the **intensity of global competition in advanced materials**. Benchmarking conducted in (European Commission, 2024a) shows that EU industrial R&I investment in advanced materials remains significantly below that of the United States. In 2020, EU investment stood at EUR 19.8 billion, compared with EUR 50.3 billion in the United States. South Korea and Japan also recorded substantial levels of investment, at EUR 19.6 billion and EUR 14.0 billion respectively, while China's industrial investment was estimated at EUR 7.7 billion.

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[154] National Strategy for Advanced Manufacturing. National Science and Technology Council. whitehouse.gov, National Strategy for Advanced Manufacturing.
[155] PRIMA Québec. (2025). 2035 Roadmap for Advanced Materials and Associated Processes.
[156] https://acceleration.utoronto.ca/.

These insights into the international context point to an **increasing recognition of advanced materials as a critical technology**, with governments seeking to deliver the policy investment needed to accelerate their development and implementation. As geopolitical uncertainty increases, unreliable international supply chains combined with new trade barriers are restricting access to critical raw materials concentrated in a limited number of sources.

This access is not just important from an economic competitiveness perspective; it can also be critical for national and regional security. Advanced materials are increasingly **essential for the technologies and assets underpinning modern socio-economic systems**, including medical devices, semiconductors, clean energy technologies, mobility systems and defence applications. China's dominant position in rare earth supply chains and its growing role in advanced materials patents are therefore creating potential risks of supply disruption, with significant implications for the EU's economic resilience.

Implications of the policies in other global regions for the EU approach

As discussed in Section 3, Europe is facing challenges in terms of the need to scale up production, but also sectoral challenges, such as in advanced materials for mobility (e.g. automotive and aviation). The comparison therefore suggests that the EU's challenge is twofold: it must continue to **strengthen its scientific and technological base, while also improving its ability to scale up, manufacture and deploy advanced materials** within resilient and competitive industrial value chains.

The 2024 communication 'Advanced Materials for Industrial Leadership' sets out a strategy structured around three main objectives: fostering research and development, scaling up manufacturing capacity, and accelerating market deployment.

In that context, the EU is also pursuing science and technology cooperation with countries that have strong expertise in this area, including to **diversify sourcing and supply chains**. These partnerships are based on reciprocal openness, respect for fundamental values and a level playing field, in particular through Horizon Europe and future EU R&I programmes, as set out in the 'Global Approach to Research and Innovation' communication and the Global Gateway Strategy. That strategy relies on the Team Europe approach, a cooperative framework pooling the resources of the EU and Member States, to maximise global impact and avoids duplication in international investment projects.

This approach reflects an increasingly competitive global landscape, in which strengthening the domestic R&I ecosystem around advanced materials is as important as building strategic international partnerships. Such partnerships can help increase the critical mass of knowledge, support scientific cooperation based on shared values, and reinforce Europe's position in global innovation networks.

The partnering focus further complements other measures taken to increase the EU's resilience against supply disruptions and towards the diversification of supply chains, such as the RESourceEU Action Plan. The plan aims to accelerate achievement of the objectives of the EU raw materials strategy, in particular with regard to preserving and expanding EU production of primary and secondary critical raw materials. Another measure is the Internal Market Emergency and Resilience Act (IMERA)[157] to ensure preparedness, a response system and uninterrupted movement of essential goods and services across the EU during a crisis.

Overall, the current international advanced materials landscape is characterised by intense competition, rapid technological progress and evolving policy frameworks. National strategies

[157] Regulation (EU) 2024/2747 of the European Parliament and of the Council of 9 October 2024 establishing a framework of measures related to an internal market emergency and to the resilience of the internal market and amending Council Regulation (EC) No 2679/98 (Internal Market Emergency and Resilience Act).

reflect priorities such as economic competitiveness, technological sovereignty and sustainability. Without further action, the EU's technology leadership risks being increasingly contested and giving way to industrial leadership in other regions.

6. NEED FOR ACTION

The following goals are set to address the *three main challenges* identified in the previous section:

- increase strategic autonomy for the EU's advanced materials ecosystem;
- shorten the time to market and unlock the potential of advanced materials to improve EU competitiveness;
- improve the EU's technological and industrial leadership in advanced materials.

In order to address these three goals, the proposal for a Council Recommendation defines *five pillars* around which urgent and determined actions must be taken:

1. ***Focus R&I investments on priority challenges.*** Some advanced materials are key enablers for the competitiveness of products, because they provide superior performance or reduce the dependency on critical raw materials. With specific technologies, they may also allow related goals, such as making products more circular or more sustainable, to be achieved.
2. ***Leverage digitalisation and AI.*** Digital technologies are transforming the way advanced materials are designed, developed and deployed. Interoperable data infrastructures and connected digital ecosystems are accelerating cooperation and innovation across Europe. Furthermore, artificial intelligence is having an increasingly significant impact, boosted by both the available data and progress in robotics enabling automated experimentation. As it greatly accelerates materials discovery, reduces development times and increases research productivity, Europe cannot afford to ignore this change to the way R&I is carried out.
3. ***Shorten the time to market.*** The time needed to bring a new scientific breakthrough from the lab to the market has been extensively discussed in the various consultations. It also came up in studies such as 'Production and Use of Advanced Materials' (European Commission, 2026e). The feedback received raises the need for a better link between academia and industry, for better exploitation of intellectual property, acceleration of the process through digitalisation, support for permitting and standards, and support with the scale-up of production.
4. ***Boost scaling-up and deployment.*** Scaling up production has been identified as a key challenge in the various consultations and studies referred to above. One key approach to tackling this challenge is through public procurers, as they can play a leading role in driving innovation and fostering the uptake of advanced materials, speeding up the market introduction of technologies that enable the twin transition and the EU's resilience and economic security. Additionally, Member States and the Commission can supplement this by facilitating strategic projects launched under existing relevant sectoral legislation, such as the Critical Raw Materials Act and the Net-Zero Industry Act.
5. ***Bridge the skills gap.*** A skilled workforce is fundamental both for R&I on advanced materials and for the uptake of products by industry. Key aspects highlighted in the consultations include a systemic skills shortage. The European Advanced Materials Academy identified 116 priority skills gaps across technical competencies (such as synthesis, characterisation and digital), high-priority skills gaps in circular economy competencies, and interdisciplinary talent shortage. Additionally, almost 40% of competencies identified are not represented in the current European skills, competences, qualifications and occupations (ESCO) framework, particularly in battery materials, semiconductors, and recycling technologies.

To trigger actions under these five pillars, the Advanced Materials Act is proposed for adoption as a Council recommendation, in line with the principles of subsidiarity and proportionality. It provides a strong political basis for initiating or strengthening actions and cooperation in the field of advanced materials, by proposing concrete actions from Member States designed to achieve progress in addressing the challenges identified, while at the same time being supported by targeted actions from the Commission, as also explained later in this section.

The form of a Council recommendation allows Member States to tailor implementation to their national environments, while **preserving policy flexibility** in this fast-moving technology field. It avoids additional compliance constraints and costs, considering that Member States may depart from different starting points in terms of regulatory frameworks, availability of resources and maturity of their innovation ecosystem. As the actions by Member States, companies and research and technology infrastructures are not compulsory, an agile approach can be taken that offers greater flexibility than a regulation, directive or decision, widening and diversifying the scope of engagement by stakeholders.

Legally binding EU rules were considered and eventually discarded, *first*, because they would be likely to disproportionately increase administrative burden of the implementation and enforcement and the consequent costs for the various stakeholders; and, *second*, because the existing legislation also already offers the necessary scope for launching possible further actions. Section 5.1 has shown that there is already a **dense European regulatory and policy landscape** for the European advanced materials ecosystem and the feedback from stakeholders – that responded to the call for evidence and the public consultation (as reported in Annex 1) – made a clear in request not to add further complexity. Moreover, it illustrated cases where existing legislation – such as the Critical Raw Materials Act or the Net-Zero Industry Act – could potentially be used, for instance, to launch dedicated strategic projects.

It was therefore considered that legislative measures would generate counterproductive effects by adding regulatory complexity and costs for stakeholders, while their possible advantages over a coordination-based approach would be uncertain and likely to remain marginal in terms of effectiveness, efficiency and EU value added.

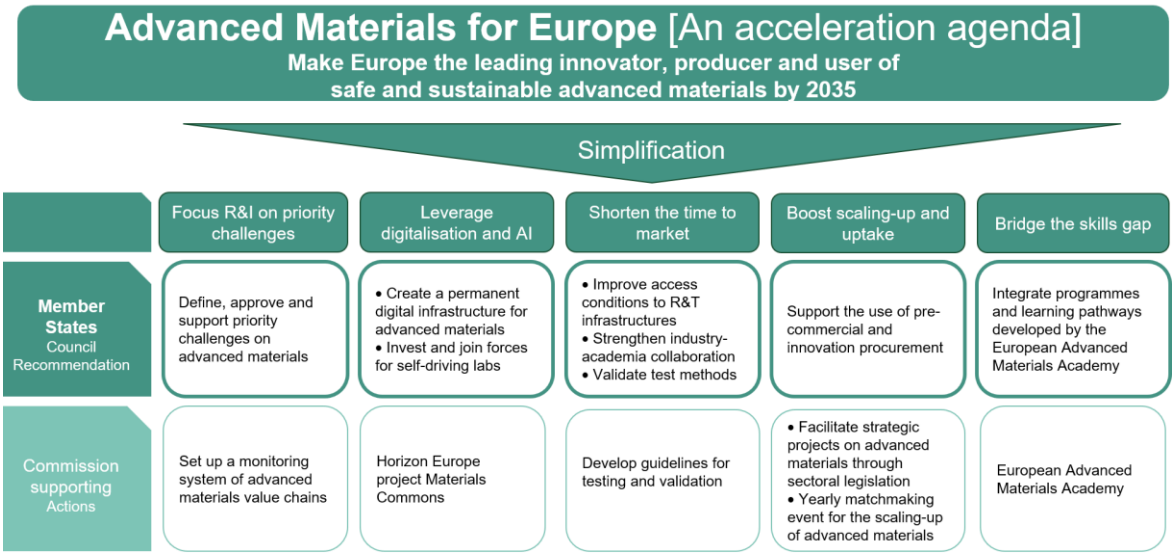
In the context of the wider policy priorities of simplification and administrative burden reduction, the option of a proposal for a Council recommendation was therefore chosen to **respect 'regulatory discipline'** – as called for by the Commission 2026 communication on better regulation[158]. It ensures that the principles of subsidiarity and proportionality are respected and prevents the creation of regulatory burdens and complexity.

To ensure that this non-binding approach has the desired impact, implementation plans and roadmaps should be prepared and a **collective agenda** built following joint discussions by Member States and consultation of stakeholders as part of anticipatory coordination efforts that use strategic intelligence in action (OECD, 2025a). This should be combined with **agile mechanisms** (OECD, 2025b) that involve co-development, the cooperation and involvement of private actors and **a 'priority challenge'-based approach**. It is proposed that progress should be monitored by the Technology Council for Advanced Materials.

The following figure shows how these five pillars could be translated into **concrete actions** and the subsequent sections give further details of the specific actions needed and the complementary support provided by the European Commission.

[158] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, A Simpler, Clearer and Better Enforced EU Rulebook, COM(2026) 380 final, 28.4.2026.

Figure 9. Actions of the proposed Council Recommendation on Advanced Materials for Europe



6.1. Focus R&I investments on priority challenges

This pillar provides for the Technology Council for Advanced Materials to **set** at least five 'priority challenges' for advanced materials in 2027, with implementation plans, funding pathways and yearly reviews, covering key areas such as energy, mobility, electronics, construction, health, aerospace and defence, as well as cross-sectoral applications, also beyond these sectors, including dual-use applications.

This pillar plays a crucial role in addressing strategic autonomy, as a **focus of R&I investments on priority challenges** can promote (1) alternatives to materials that depend heavily on critical raw (and processed) materials for their production; (2) technologies for producing advanced materials that are monopolised by third countries, or (3) advanced materials that can substitute for – and reduce the dependency on – critical raw (and processed) materials; and (4) improved production equipment and processes for manufacturing advanced materials, where dependency can arise independently of the materials themselves — in cases where control over manufacturing infrastructure constitutes a risk**.** Monitoring is therefore also crucial, in order to choose and adapt strategies to address these issues and incentivise the development of advanced materials that may provide solutions or improvements.

The European Commission, with the assistance of its Joint Research Centre, will support this by setting up a monitoring system for advanced materials value chains, to analyse strengths and strategic dependencies and provide information for future priority challenges and actions. About five value chains are to be selected for each analysis cycle, with the first selection planned for early 2027 and conclusions in 2028.

Priority challenges

The **Technology Council for Advanced Materials** will be the main governance forum to identify and agree **key R&I 'priority challenges'** for a competitive, resilient and better-coordinated EU advanced materials ecosystem. The technology council is viewed as the appropriate vehicle because the Commission's 2024 communication already assigns it a role in identifying common objectives and priority areas for coordinated action, bringing together Member States, industrial stakeholders, research actors and the Commission.

The aim is to identify and set out a number of key actions for research and innovation that are important for attaining a competitive and resilient EU advanced materials ecosystem, yet with a particular focus. These should be instrumental in helping to increase advanced materials production capacity in Europe, reduce supply risks and bridge gaps in circular value chains. As such, the actions should help to reduce the EU's value chain dependencies and increase Europe's strategic autonomy.

This would move beyond broad priority-setting by developing an **implementation plan** for each agreed priority challenge, including a pathway for the 'innovation-to-investment journey', by laying out a collective agenda to address the challenges, identifying the relevant actors and the appropriate funding route and deciding whether the action is better addressed through EU-level support, national programmes or joint EU-Member State activity. Its value lies in **making use of existing and future funding streams**, including Horizon Europe, the European Competitiveness Fund, national programmes and industry investment, around a smaller number of jointly agreed advanced-materials priorities.

The priority challenges should include of a description of:

- actions to be taken and their priority;
- actors involved and roles at EU and Member State level;
- implementation plans;
- funding mechanisms.

Addressing the priority challenges could build on the monitoring mechanism for advanced materials value chains, to be set up by the European Commission. The members of the Technology Council for Advanced Materials would have an important role, in cooperation with the Commission. The technology council should discuss possible actions to be taken as a joint activity at EU level, as well as those that are better addressed at Member State level using national programmes.

Setting priority challenges and corresponding implementation plans would help to:

- align EU, national and private R&I efforts around shared priorities, reducing fragmentation and improving investment impact;
- improve smart specialisation and better use of technology infrastructures, while avoiding duplication;
- increase resilience by using strategic intelligence to identify supply risks and turn them into targeted R&I and deployment priorities;
- better align advanced-materials action with climate, circularity and sustainability goals.

Monitoring mechanism

This action engages the Commission, supported by the Technology Council for Advanced Materials, to monitor and analyse the advanced materials ecosystem, covering supply chains, dependencies, and economic importance for application sectors in energy, mobility, construction, electronics, medical devices, aerospace and defence, as well as cross-sectoral applications, also beyond these sectors, including dual-use applications. The monitoring will identify the EU's strengths, capabilities and dependencies, and the emergence of new advanced materials with potential to substitute for critical raw materials, contribute to circularity, or improve performance to drive competitiveness in the sectors under scope.

The Technology Council for Advanced Materials will select technologies and products for analysis, contribute to the analysis, validate outcomes, and discusses follow-up actions. This process will

create synergies with the Observatory of Emerging Technologies and the Observatory of Critical Technologies. Outcomes also support programming under the future MFF, particularly Horizon Europe 2028-2034 and the European Competitiveness Fund.

The monitoring will be carried out by the Commission's Joint Research Centre, which will analyse and monitor the resilience of advanced materials value chains, including strengths, capabilities and dependencies of the EU for advanced materials and related technologies, including emerging ones and the EU's capacity to develop them, which can contribute to one or more of the following points:

- substitute/reduce use of critical raw materials;
- improve circularity;
- improve performance of technologies/products.

The monitoring will analyse the advanced materials ecosystem for selected technologies and products related to advanced materials, which will be selected approximately every two years for in-depth analysis. The Commission will implement the monitoring, building on the process being developed and tested under the risk assessment of the Economic Security Strategy. Outcomes may also support the work on 'priority challenges'.

6.2. Leverage digitalisation and AI

This pillar provides for the creation of a permanent EU digital infrastructure for advanced materials R&I data, the Materials Commons. Its aim is to provide high-quality, AI-ready data and reduce fragmentation in the research and innovation ecosystem for advanced materials. The preferred approach, proposed for consideration by Member States, is to create the specific legal form of a European Research Infrastructure Consortium[159] for that purpose.

Additionally, it provides for investments in – and coordination of – self-driving labs combining AI models and robotics for accelerated materials discovery, testing, prototype validation and scale-up. Member States are invited to adopt a roadmap by the end of 2027, and the first such labs should be operating by 2030 at the latest.

Creation of a long-term virtual infrastructure

Despite the significant progress made by existing (national) initiatives such as Materials Cloud, MaterialDigital, DIADEM, CAPeX, NOMAD, MaX, FAIRmat and others, the current digital landscape for materials remains highly fragmented (see Sections 3.3 and 4.4 above). The main limitation or challenge lies in the **lack of interoperability and the absence of connections** between these platforms. Current solutions are often tailored to specific materials systems, applications, or stakeholder groups. Many of these restrictions are artificial, stemming from national strategies or funding schemes, which results in parallel work that wastes valuable resources and confines users to a limited set of solutions. Combining different solutions will create significant synergies.

The European **Materials Commons** infrastructure is a federated digital infrastructure for advanced materials R&I. Its purpose is to reduce fragmentation in Europe's materials science and engineering landscape and address the currently low level of digitalisation by linking researchers from industry and academia and connecting currently isolated national or project-based resources. The initial build-up is taking place through the Horizon Europe 'Materials Commons' project[160] with funding of EUR 28 million for 2026-2030, involving 52 collaborating entities, including

[159] https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/european-research-infrastructures/eric_en.
[160] https://www.materialscommons.eu/.

ministry-mandated national hubs from 11 Member States and two associated countries, plus additional partners from two further Member States and two further associated countries.

By overcoming the current fragmentation and data incongruence and achieving a data semantics framework, where the meaning of the data is consistent and precise as it flows across sectors and along value chains, the infrastructure provides better access to quality data from different sectors (including materials structure, properties, processability, performance, safety and sustainability). It is intended to become the main access point for a European materials research and engineering community of around 100,000 people[161].

A long-term solution, beyond 2030, could be built on a legal entity, for example a European research infrastructure consortium (ERIC)-type structure. The process of setting it up should start by 2028, given an estimated two-year set-up period for the governance structure.

A long-term solution for the Materials Commons is expected to contribute mainly to four economic effects: (i) reducing time to market for new advanced materials; (ii) increasing advanced-materials R&I investment and industry-academia collaboration; (iii) improving the visibility and utilisation of EU technology infrastructures; and (iv) supporting higher patenting and commercialisation indirectly through better data access and lower discovery costs. By reducing fragmentation and creating high-quality tools, and making data and interoperable workflows readily accessible, the infrastructure would help shorten the time needed to move from materials discovery to industrial applications.

This contribution is relevant to a wide range of stakeholders, including academia, research organisations, industry and SMEs. It has links to regulatory and safety/sustainability aspects such as digital product passports and the SSbD framework[162], as the information required for those regulatory processes could be available through the Materials Commons, and tools can be provided to facilitate its use and related workflows. At the same time, the initiative would help to make the advanced materials ecosystem more AI-ready by promoting better data availability, interoperability and digital integration, creating more favourable conditions for the uptake of artificial intelligence in advanced materials development.

Invest in and join forces on self-driving labs

It is necessary to develop a European strategic approach to **self-driving labs**, which serve universities, research organisations and SMEs, while also being relevant to larger companies that may prefer access to shared facilities over building their own in-house laboratories (see also Section 3.3).

Implementation will require identification of existing highly autonomous closed-loop experimentation infrastructures; consultation with large industry and SMEs on their needs and potential engagement; and consideration of national or joint European funding for the development of such infrastructures. Proposed action from Member States would be accompanied by Commission-led strategy work through the technology council, including a subgroup in Q1 2027, a draft **roadmap** in Q2 2027, stakeholder consultation in Q3 2027 and Member State commitments by Q4 2027.

Self-driving labs are closely linked to the 'Materials Commons' and their data and digital framework. They should be designed as virtual and distributed infrastructures for low TRL, while the Materials Commons will provide the framework to interconnect equipment at different locations in a seamless, interoperable fashion, creating opportunities for researchers all over

[161] Estimate based on membership of professional societies.
[162] https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/european-ai-science-strategy/raise-resource-ai-science-europe_en.

Europe. For high TRL, as a generic self-driving lab is not feasible, different specialised self-driving labs would be needed across Europe.

An existing example of a self-driving labs in Europe can be found at the Danish CAPeX Pioneer Center for Accelerating P2X Materials Discovery at the Technical University of Denmark, which received about EUR 40 million in support over 13 years to set up a specialised self-driving lab for energy materials discovery. Public information on CAPeX describes it as a materials acceleration platform expected to increase the pace of development of new materials by five to ten times[163]. This provides a useful, though still imperfect, benchmark for the order of magnitude of both potential benefits and likely costs. An example from outside Europe is the Berkeley A-Lab[164]: it synthesised 36 compounds from 57 targets in 17 days of continuous operation, showing the potential of robotics, large databases, machine learning and active learning.

Public, specialised self-driving labs should act as shared experimentation infrastructure for research actors at high TRLs, including industry and especially SMEs. This is in keeping with evidence from the consultation: over 90% of respondents saw stronger industry-academia-research links as effective or very effective in reducing time-to-market, while almost 90% said the same of investment in technology infrastructures and testbeds. CAPeX illustrates this model, involving five Danish and three international universities, leading to stronger industry-academia cooperation.

Because such self-driving labs are a capital-intensive measure, the uptake scenarios are best determined by the number of operational specialised nodes, the degree of Member State commitment and the scale of cross-border use, rather than by a simple binary notion of adoption.

Self-driving labs for advanced materials are expected to generate substantial productivity, innovation and sustainability gains across Europe's R&I ecosystem. By creating a higher experimental throughput, it will increase the number of patentable and commercialisable leads by lowering the cost of materials discovery and development.

The Resource for AI Science in Europe[165] (RAISE) also provides a framework to strengthen the use of AI in scientific discovery, including for materials research. It also launched a Horizon Europe call for proposals or research and innovation actions for self-driving laboratories under the Horizon Europe work programme for 2027[166].

6.3. Shorten the time to market

This pillar provides for improved access for SMEs, start-ups and scale-ups to research and technology infrastructures for testing and qualification, and awareness-raising campaigns supported by Commission workshops in 2027.

It also plans to strengthen industry-academia cooperation by promoting matchmaking, proof-of-concept schemes and collaborative licensing models, alongside better intellectual asset management in academia, supported by Commission workshops in 2027 and 2028.

Furthermore, time to market can be accelerated by validated, standardised test methods for the qualification of advanced materials and guidelines on the safety and sustainability assessment of advanced materials, simplifying hurdles when going to market. This can build on work by the

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[163] https://capex.dtu.dk/, https://dg.dk/en/centers/pioneer-center-for-accelerating-p2x-materials-discovery-capex/.
[164] https://newscenter.lbl.gov/2023/04/17/meet-the-autonomous-lab-of-the-future/.
[165] European Commission, 'RAISE: Resource for AI Science in Europe', available at: https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/european-ai-science-strategy/raise-resource-ai-science-europe
[166] See Automated Scientific Discovery (RAISE pilot) (RIA) with EUR 29 million in funding (HORIZON-RAISE-2027-01) with a focus on materials science and another dedicated call for proposals with a focus on food: Automated Scientific Discovery – Food (RAISE pilot) with EUR 3 million in funding (HORIZON-RAISE-2027-01-02).

OECD and the European Partnership for the Assessment of Risks from Chemicals, for example, as well as on AI methods and computational modelling.

The Commission will support this by developing sector-specific guidelines for advanced materials testing and qualification, tailored to regulatory environments in energy, electronics, mobility, construction, health and aerospace, as well as cross-sectoral applications, also beyond these sectors, including dual-use applications.

Test methods and guidelines on advanced materials testing and qualification

The purpose of this measure is to compile sector-specific guidelines providing examples and best practices for selecting and applying appropriate testing and assessment approaches to generate the evidence needed to assess the safety, functionality, environmental performance and sustainability of advanced materials and their suitability for the intended application. These guidelines should support both innovators and regulators. By promoting the use of fit-for-purpose methods throughout the innovation process, the guidelines will facilitate early decision-making, reduce uncertainty, promote SSbD approaches, and streamline the generation of evidence required for regulatory decision-making and compliance. This is expected to help reduce development costs, minimise late-stage failures and accelerate time-to-market. At the same time, the guidelines will support regulators by facilitating the generation of robust, reliable and relevant evidence, contributing to efficient regulatory processes while maintaining a high level of protection for human health, animal health and the environment. As such, this measure helps to reduce the innovation deployment gap and unlock the potential of advanced materials to foster EU competitiveness while ensuring a high level of protection for human health, animal health and the environment.

The guidelines will be designed by identifying and taking stock of existing hurdles for each of the relevant sectors concerning regulatory compliance and testing and by qualifying the production and uptake of advanced materials, as will as their suitability for their intended application, and subsequently setting best practices to overcome those challenges. This should be a multistakeholder approach involving Member States, regulators, industry, testing laboratories, standardisation bodies, researchers and academia, incorporating for instance sector-specific workshops, inquiries, and analyses.

This action would result in clear and useful guidelines for various high-impact sectors, notably energy, mobility, construction, electronics, medical devices and defence, and aerospace, which provide solutions for addressing the regulatory compliance challenges and testing and qualification hurdles that have been identified. The guidelines are expected to be practical and user friendly, focussed on a particular sector and target audience in the advanced materials ecosystem. It is expected that these guidelines will help shortening the time-to-market of newly developed advanced materials and facilitating their uptake.

Regulatory sandboxes

Regulatory sandboxes offer a structured framework for experimentation, for a limited time and under supervision of the competent authorities. They can help verify that the regulatory framework remains fit for purpose and also provide regulatory clarity for developers of innovative products/services that may not fit easily into the existing rules.

The Commission has recently adopted a proposal for a Council recommendation on common principles on regulatory sandboxes to support innovation and a future-proof regulatory framework[167]. It sets out a proposed definition and common principles for their establishment,

[167] COM(2026) 568 final, 9.9.2026.

supervision and cross-border operation. At EU level, the set-up of regulatory sandboxes to experiment with advanced materials can be facilitated, where relevant, by applying existing EU sectoral legislation, such as in the Net-Zero Industry Act[168] or the AI Act[169].

Regulatory sandboxes have increasingly been used as practical tools to test innovative solutions at product or application level in a controlled environment, primarily in the sectors of transport and mobility, followed by environment, digital and energy. At national level, 132 ongoing and closed regulatory sandboxes were identified in a 2025 survey report (European Commission, 2026j). The survey also shows that 76% of sandboxes reported were concentrated in Germany (*Reallabore)*[170] and France (*Bac à sable réglementaire – France Expérimentation)*[171] and that these are not focused on individual (advanced) materials. Practical examples of regulatory sandboxes in the area of advanced materials are hard to find (European Commission, 2026a; see also Section 3.2). However, Sweden's innovation agency Vinnova has, for instance, prepared a report with proposals for how net-zero regulatory sandboxes could become a strategic innovation tool so that new technology can be tested more quickly and come to market (Vinnova, 2025).

Improve access for SMEs, start-ups and scale-ups to research and technology infrastructures

Improving the access conditions for SMEs, start-ups and scale-ups to the EU's research and technology infrastructures can be instrumental in bridging the advanced materials innovation deployment gap. Swifter access conditions may lead to faster standardisation processes and help guide SMEs, start-ups and scale-ups through the complex regulatory environment. As such, this action is primarily focused on attaining the third specific objective of enhancing 'the role of technology infrastructures to respond better and faster to regulatory needs, and to standardisation'. Consequently, the time to market should be accelerated.

Harmonised access rules and awareness raising will be promoted via the Charter of access for industrial users to research and technology infrastructures[172]. The Charter formulates the principles and guidelines for accessing research and technology infrastructures in the EU and will simplify access for companies to the EU's world-class research and technology infrastructures, especially for SMEs, start-ups and scale-ups.

The Charter aims to improve access in six ways[173]:

1. increased visibility and availability of services;
2. transparency and quality of services;
3. simplified contract and agreement procedures;
4. safe intellectual property management;
5. priority access to companies in the EU; and
6. cooperation between infrastructure and access to data.

The Charter for industrial users complements the revised Charter for Access to Research Infrastructures (see European Commission, 2024b) and is an action stemming from the EU Startup

[168] Regulation (EU) 2024/1735.
[169] Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain Union legislative acts, COM(2021) 206 final, 21.4.2021.
[170] See also https://www.bundeswirtschaftsministerium.de/Redaktion/EN/Dossier/regulatory-sandboxes.html and https://www.reallabore-innovationsportal.de/reallabore/landkarte.php.
[171] https://www.modernisation.gouv.fr/projets-accompagnes-par-france-experimentation.
[172] Communication from the Commission, Charter of access for industrial users to research and technology infrastructures, C/2026/4100, 28.7.2026.
[173] See European Commission, 2025, news article 'Commission seeks feedback on the future Charter of access for industrial users to research and technology infrastructures', 13 November 2025, Commission seeks feedback on the future Charter of access for industrial users to research and technology infrastructures – Research and innovation.

and Scaleup Strategy[174], while also taking into account the objectives of the European strategy on research and technology infrastructures[175].

The roll-out of the Charter is expected to be able to improve access to the EU's top research and technology infrastructures across a wide range of advanced materials and sectoral applications. There are also plans to simplify the access rules. This would improve access conditions for SMEs, start-ups and scale-ups to research and technology infrastructures. Additionally, state aid rules also provide for such facilitation in the case of State aid R&D projects (e.g. transparent and non-discriminatory access to research/testing and experimentation infrastructures).

Another policy action with the potential to improve access to research and technology infrastructures is voucher schemes applicable across the EU. Such schemes provide direct financial support to offset high service fees from research and technology infrastructure services. This enables small businesses to access services for testing, qualification and upscaling more quickly. Particularly in the context of cross-border facilities the property of being 'portable' across Member States is important. It should thus be promoted that vouchers issued in one Member State should be valid also for financing access to research and technology infrastructures in another Member State.

Both policy aspects are expected to be reinforced by the planned European Research Area Act, through enabling provisions regarding publicly funded infrastructures and their public access policy. In addition, the Commission is already supporting the development of pilot schemes for access to technology infrastructures through current Horizon Europe calls[176]. Although those calls are not specifically targeting the field of advanced materials, the experience gained through the deployment of voucher schemes and a single-entry point can help develop similar schemes applicable to advanced materials technology infrastructures across the EU.

Strengthen industry-academia cooperation

The aim of this group of actions is to strengthen the collaboration between academia and industry in the advanced materials ecosystem and improve the efficiency and performance of the EU's research and innovation ecosystem for advanced materials. This should bridge the gap between industry and academia (see also Section 3.1) and consequently make the advanced materials research and innovation ecosystem less fragmented. This, in turn, will improve the EU's technological leadership.

Through a combination of policy support, funding, and ecosystem-building initiatives, Member States can strengthen cooperation between industry and academia and promote the commercialisation of research results related to advanced materials. This could include:

- providing access to dedicated public funding instruments for testing, qualification and prototyping such as proof-of-concept voucher schemes;
- promoting strategic approaches to intellectual asset management and technology transfer and facilitating cooperation between industry and academia, including through collaborative IP licensing models and templates, patent pools, partnering agreements, joint ownership with joint exploitation mechanisms, open licensing with open innovation, consortium-based licensing, data-sharing and data-licensing frameworks, taking into account applicable EU state aid and competition rules where relevant;

[174] See e.g. EU Startup and Scaleup Strategy – Research and innovation.
[175] See e.g. The European Strategy on Research and Technology Infrastructures - Research and innovation.
[176] See for instance HORIZON-CL4-2026-01-MAT-PROD-45: Pilot access schemes to Technology Infrastructures for European startups, scaleups and innovative SMEs (CSA) on the EU Funding & Tenders portal.

- guidance on co-creation methods, open innovation and valorisation best practices;
- capacity building of technology transfer offices and network creation between these offices for increased commercialisation, e.g. via support for effective intellectual property management in the field of advanced materials.
- promotion of the Materials Commons digital R&I infrastructure among industrial developers.

Together, such actions would improve the availability and usability of research results, with the aim of accelerating valorisation and market uptake by fostering co-creation between academia and industry on the basis of specific advanced materials challenges, supporting open innovation and collaborative licensing models and strengthening intellectual-asset management within academia. It would be helpful to achieve the goals by increasing the volume and intensity of cooperation through open innovation platforms and matchmaking action and the guidance on co-creation and valorisation, improved valorisation and commercialisation, dedicated public funding instruments such as proof-of-concept and demonstration projects, strengthened IP management and licensing templates.

6.4. Boost scaling up and uptake

This pillar provides support for several opportunities to use existing instruments to boost the scaling and uptake of advanced materials, with particular focus on the needs of start-ups and scale-ups. This includes the use of pre-commercial procurement and innovation procurement for advanced materials, the designation of industrial manufacturing acceleration areas under the proposed Industrial Accelerator Act, strategic projects launched or to be launched under the Critical Raw Materials Act or the Net-Zero Industry Act and Important Projects of Common European Interest[177].

Complementary support for matchmaking and networking opportunities for advanced materials companies at EU, national and regional levels should also be provided (e.g. as part of national or regional programmes and innovation ecosystem initiatives, cluster organisations and other business support network organisations). The European Commission will also facilitate the organisation of annual matchmaking events for scaling up advanced materials production in cooperation with the European partnership on advanced materials (IAM4EU) and the EIC, to connect start-ups and scale-ups with large industrial producers and users in Europe.

Support the use of R&D procurement, public procurement of innovative solutions and promote advanced materials projects

Public procurers can play a leading role in driving innovation and fostering the uptake of advanced materials, speeding up the market introduction of technologies that enable the twin transition and the EU's resilience and economic security. The Commission's proposals for a Public Procurement Act[178] is a key piece of legislation supporting this opportunity. Public research and development (R&D) procurement, including pre-commercial procurement, and the use of non-price award criteria (such as functional requirements and, where necessary, performance requirements), that makes better use of advanced materials can potentially achieve a substantial impact towards

[177] Communication from the Commission - Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest (2021/C 528/02).
[178] Proposal for a Regulation of the European Parliament and of the Council on public contracts and concessions, repealing Directives 2014/23/EU, 2014/24/EU and 2014/25/EU, and amending Regulations (EC) No 1370/2007, (EU) 2023/1542, (EU) 2024/1157, (EU) 2024/1252, (EU) 2024/1735, (EU) 2024/1781, (EU) 2024/2847, (EU) 2024/3110 and (EU) 2025/40, and Directives 2008/98/EC, (EU) 2019/882, (EU) 2022/2381, (EU) 2023/1791 and (EU) 2024/1760 (Public Procurement Act), COM(2026) 590, 9.9.2026.

achieving these policy objectives in all areas where the public sector is an important customer, such as construction, mobility, electronics and energy, creating key footholds for start-ups and scale-ups. Examples of functionalities that could potentially be achieved through advanced materials include thermal isolation and protective coatings in construction, superior reliability and durability of energy and mobility infrastructures, improved performance of electronic devices, increased circularity and cost-efficient maintenance of products.

De-risking R&D procurement and aligning it with EU policy priorities enables public authorities to act as catalysts for market transformation. SMEs, start-ups, scale-ups, and research institutions will gain clearer routes to market. This can support uptake and help to bridge the gap between first deployment and large-scale production and contribute to the creation of European lead markets for emerging technologies. The proposed European Innovation Act[179] has the potential to broaden the use by laying down a common procedure for R&D procurement and thus providing legal certainty for public buyers and innovators, including for joint cross-border R&D procurement.

Standardisation and technical harmonisation can further support market uptake by reducing uncertainty, improving interoperability and facilitating the deployment of advanced materials across sectors.

On the basis of the European Critical Raw Materials Act, strategic projects are recognised by Commission decision with the aim of increasing EU capacity to extract, process and recycle strategic raw materials and diversify EU supplies from third countries. These projects make a significant contribution to the security of the EU's supply of strategic raw materials, becoming technically feasible within a reasonable time frame and showing expected production volumes and implemented sustainably. Several of these projects are linked to advanced materials (e.g. in the area of solid-state batteries, lithium-free batteries, cobalt-free cathodes, rare earth element-free magnets).

Similarly, the Net-Zero Industry Act allows project promotors to apply to be recognised as net-zero strategic projects increasing the resilience, strategic autonomy, and competitiveness of the EU's net-zero industry while aiming to scale up manufacturing of technologies essential for climate-neutrality. In this case too, many projects focus on advanced materials (e.g. perovskites or graphene coatings for solar energy, carbon fibre-reinforced polymers and rare earth element-free magnets for wind energy, battery materials, metal organic structures for aviation fuel).

Strategic projects provide several tangible benefits: priority status at national level, streamlined and faster permitting and administrative procedures, as well as financing advice, and increased visibility and coordination at European level. Facilitating these projects is key to building a more resilient, secure and sovereign Europe. Under the Net-Zero Industry Act, projects may submit their applications through the relevant Commission website[180] for assessment and potential designation by the Member States concerned. In this context, the Commission and Member States should continue raising awareness of this opportunity and encouraging relevant projects, including those in the advanced materials sector, to make use of this framework.

6.5. Bridge the skills gap

This pillar centres on the emerging knowledge and skills needs, labour market trends and how the European education system can respond to these. The Commission proposal for a Council recommendation invites Member States to support the mapping and forecasting of such knowledge

[179] Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures for strengthening the Union innovation ecosystem and amending Regulation (EU) 2017/1001 (European Innovation Act), COM(2026)567 final, 9.9.2026.

[180] https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act/strategic-projects-under-nzia_en.

and skills needs in advanced materials, and to strengthen education and training in science and technology disciplines related to advanced materials in national curricula and lifelong learning strategies and programmes. Education, training and lifelong learning systems should respond to emerging industrial, technological, research and regulatory needs in advanced materials. Basic skills, including digital skills and AI literacy, as well as STEM skills[181], are essential in an increasingly AI-driven world, and education systems play a crucial role in ensuring that all citizens can develop the capabilities needed to succeed. The proposal also provides for the effective use of programmes, learning pathways, innovative lifelong learning approaches such as Individual Learning Accounts (ILAs), micro-credentials, industry-aligned training materials, train-the-trainer programmes and SME starter packages, including those developed by the European Advanced Materials Academy.

Building on the programmes and learning pathways developed by the European Advanced Materials Academy

The European Advanced Materials Academy was launched on 15 October 2025 at the European Institute of Innovation & Technology (EIT) Education & Skills Days. It was set up with the support by the European Commission's Directorate-General for Research and Innovation and its implementation is led by EIT Raw Materials[182]. It is a flagship initiative under the EU's Union of Skills strategy that aims to train 200 000 learners by 2029. The academy is further embedded in EU skills strategies and policies, such as the Pact for Skills, centres of vocational excellence, European Universities alliances, and links with related academies, such as the Net-Zero Industry Academies[183] and the Critical Raw Materials Academy[184].

The purpose of this measure is to improve and enhance the skills needed in the EU advanced materials ecosystem, to indirectly bridge the innovation gap and to help unlock the potential of advanced materials to increase the EU's competitiveness. More specifically, the goal is to integrate the programmes and learning pathways developed by the European Advanced Materials Academy into the Member States' educational plans.

The measure offers a portfolio of multilingual, modular and accredited learning programmes across the advanced materials ecosystem and includes:

- skills-first learning pathways for students and professionals and micro-credentials;
- industry-aligned training in e.g. sustainable by design innovation;
- train-the-trainer programmes; and
- SME starter packages.

Liaising with the European Advanced Materials Academy would give Member States the opportunity to adopt the learning pathways and integrate the programmes of the academy into national educational curricula for students and national initiatives to train, upskill and reskill workers and hence foster the deployment of innovation in their respective advanced materials ecosystems. The cooperation with the academy can be done in various ways, e.g. by using memorandums of understanding to commit to integrating courses into the national education programmes or, conversely, by providing feedback from national advanced materials initiatives on skills and training needs to the academy, promoting the academy's portfolio of programmes to

[181] STEM is an umbrella terms that groups Science, Technology, Engineering, and Mathematics.
[182] See e.g. EIT RawMaterials to lead new European Advanced Materials Academy | EIT RawMaterials – Developing raw materials into a major strength for Europe.
[183] See e.g. GROWTH – With the Net-zero Industry Academies, the Commission acts to train Europe's workforce for the net-zero economy.
[184] See e.g. European Raw Materials Academy | EIT RawMaterials – Developing raw materials into a major strength for Europe.

educational organisations, schools and lifelong learning organisations, appointing national coordinators. Additionally, a feedback and monitoring scheme could be set up at Member State level to assess progress and effectiveness in view of the perceived skills needs in the advanced materials ecosystem.

The academy has identified and prioritised **critical skills needs**. For instance, it carried out a 'skills needs assessment on advanced materials' which identified 116 skills gaps across 22 clusters. It has found that the challenge is one not only of labour supply, but also of system design: 40% of the skills identified are not adequately reflected in the current European skills, competences, qualifications and occupations (ESCO) framework[185], limiting their recognition, certification and integration into training provision. The assessment shows that the most acute shortages are concentrated in downstream segments of the value chain, in particular use-phase, recovery and recycling activities. While Europe retains comparative strength in materials discovery and design, significant weaknesses persist in circularity-related capabilities, including end-of-life processing and resource recovery. At the same time, digital and sustainability-related competences are emerging as horizontal priorities, with AI and machine learning for materials R&D, as well as circular economy and life cycle-oriented skills, being identified as increasingly important across workforce levels.

The report also points to a structural mismatch between training demand and the existing provision. Several high-priority areas, including internet of things and smart manufacturing, traceability and regulatory compliance, technical ceramics and refractories, and photovoltaics and solar materials, currently lack dedicated training coverage across the EU. Generic AI and virtual reality courses, by contrast, are comparatively abundant, despite often lacking a materials-specific focus.

The assessment therefore highlights **10 priority skill clusters for immediate attention**, including circular economy and sustainability, AI, battery materials and energy storage, semiconductors and electronics, and traceability and regulatory compliance.

Action in this area will strengthen cooperation on curriculum development between industry, education and public actors. This will help to close the identified advanced-materials skills gap by building up a qualified workforce trained against industry-validated, EU-wide curricula.

A further benefit is the substitution of some of the recruitment and in-house training costs currently borne by EU advanced materials employers. A firm that would have develop its own advanced materials technical training in-house can instead send its workers to an academy-aligned course, substituting public provision for firm-funded training. The indirect mechanism operates through the labour market: as trained workers enter the workforce, the supply of qualified candidates rises, recruitment search times shorten and per-hire recruitment costs fall.

While building on this resource, Member States should also consider linking such actions to European Universities alliances, Marie Skłodowska-Curie actions, Erasmus+ actions and the Choose Europe initiative to attract, develop and retain global talent for advanced materials research and innovation in the EU.

Also, as part of the flagship initiatives of the upcoming Education Package put forward by the European Commission, the European Digital Infrastructure Consortium for education (EDU-EDIC) aims to build sovereign, interoperable digital infrastructure for education. Its core mission is to break Europe's dependence on non-EU providers, to keep the data of millions of educators and learners securely within EU borders, and to foster a trusted, inclusive and innovative digital learning ecosystem across participating Member States.

[185] https://esco.ec.europa.eu/en

6.6. Summary of actions taken by the Commission

This section gives a brief summary of the actions – while already described in previous sections – that will be taken by the Commission to support and complement those that Member States may take in order together to help strengthen competitiveness, especially for start-ups and scale-ups, strategic autonomy and simplification.

- a monitoring system for advanced materials value chains, supported by its Joint Research Centre, to analyse strengths and strategic dependencies and provide information for future priority challenges and actions.
- continue to support the Materials Commons and work with Member States to create a permanent solution for the digitalisation of R&I in advanced materials. It will also use this and other frameworks (such as RAISE) to support the roadmap for self-driving labs.
- develop sector-specific guidelines for advanced materials testing and qualification, tailored to regulatory environments in energy, electronics, mobility, construction, health and aerospace.
- organise match-making events bringing together start-ups, scale-ups and other stakeholders such as industry and investors, to foster the take-up of results, co-creation and valorisation of knowledge.
- help strengthen education and training in Europe through the opportunities offered by the Advanced Materials Academy.

7. CONCLUSIONS

This staff working document shows that the EU has a strong advanced materials R&I ecosystem, with an extensive network of 2 943 research and technology infrastructures active in advanced materials and relevant network initiatives. However, it also demonstrates that the ecosystem remains fragmented and suffers from a disconnect between research and innovation – despite considerable investments having been made.

The document shows that the EU is an important player on the world market for advanced materials and has a trade value surplus in that sector, focusing more on high added value than on high-volume goods or those products that rely heavily on critical raw materials. It also points to the EU's untapped potential and outlines the challenges it faces in fully translating its scientific strength into industrial strength. This includes a lack of scale-up capacity, regulatory complexity, lack of monitoring capacity, and lengthy testing and certification requirements.

In addition, the document highlights that the EU is facing increasing competition in innovation activities by its main competitors, as exemplified by its share of around 10-15% of global patents applications which is in danger of falling further.

The document also gives an overview of strategic dependencies and substitution possibilities across the strategic areas identified – energy, mobility, construction, electronics and health (medical devices) and aerospace and defence – given the key role that advanced materials play in those sectors. It underlines that, without further action, the EU's technology leadership risks being increasingly contested, giving way to leadership in other regions.

This document therefore makes a case for urgent joint actions and more coordinated investments to exploit the opportunities from the increasing demand. It also calls on the EU to unlock the full potential of advanced materials to increase its competitiveness. It points to the need to increase strategic autonomy and improve the EU's technological and industrial leadership by addressing the

challenges of value chain dependencies, the persisting gap between innovation and deployment, and the fragmentation of its R&I ecosystem.

An integrated approach is outlined, presenting necessary actions around five pillars to: (i) prioritise R&I investments on priority challenges; (ii) leverage digitalisation and AI; (iii) shorten time to market; (iv) boost scaling-up and deployment; and (v) bridge the skills gap.

The measures presented offer opportunities to strengthen the EU's advanced materials ecosystem through a coordinated but non-binding approach centred on voluntary action by Member States and engagement by stakeholders. Focusing of R&I investments on 'priority challenges' will strengthen cooperation between academia and industry. Following such an approach could improve the commercialisation of research results, the EU's supply security and circularity and help align research and innovation priorities with industrial needs and sustainability goals. The proposed monitoring mechanism and priority-setting process could provide strategic intelligence and allow informed decisions to be made on where to invest, specialise and act together.

Several measures aim to reduce the delay between breakthroughs in the lab and industrial deployment. These include easier access for SMEs, start-ups and scale-ups to research and technology infrastructures through harmonised access rules and voucher schemes, better materials testing and qualification support, and more practical guidance for regulatory compliance in key sectors. Open innovation platforms, proof-of-concept support, collaborative licensing models and more effective intellectual asset management can also help translate research into marketable applications.

The creation of more connected, AI-ready data and digital tools for advanced materials data – including the consolidation of the 'Materials Commons' as a permanent European digital R&I infrastructure and the development of self-driving labs to increase experimental throughput – should further reduce fragmentation, improve interoperability, provide broader access to high-quality data, faster testing, and lower development costs for researchers and companies. This is expected to accelerate discovery, improve cooperation across borders and sectors and indirectly support patenting, commercialisation and scale-up.

Innovation procurement and pre-commercial procurement should also be used as a key tool for public authorities to act as lead users of advanced materials and create clearer routes to market for innovators. Strategic projects linked to relevant EU legislation are also expected to allow faster permitting, better visibility, financing advice and stronger coordination for scaling up manufacturing and deployment in areas such as batteries, solar, wind and other strategic sectors. Lastly, integrating learning pathways from the European Advanced Materials Academy into national education and training systems will increase the availability of relevant skills across the advanced materials ecosystem.

The Commission proposal for a Council recommendation suggests a number of general benchmarks and key performance indicators that will allow progress made in its implementation to be monitored.

For the proposed Council Recommendation on Advanced Materials for Europe to successfully ensure that the European Union will be a leading innovator, producer and user of safe and sustainable advanced materials, joint efforts must be made by all involved – Member States, national and regional authorities, industry, academia, and other stakeholders. A truly collective agenda needs be developed that will require focus, speed and scale in its implementation of the proposed actions.

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ANNEX 1: CALL FOR EVIDENCE AND PUBLIC CONSULTATION

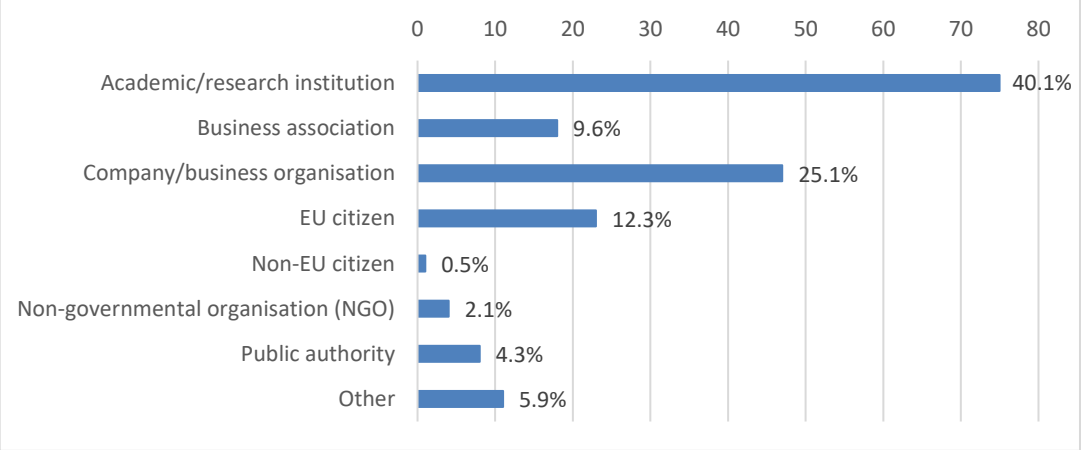
Introduction

As part of the preparation of the proposed Council Recommendation on Advanced Materials [Advanced Materials for Europe], a public consultation was carried out to obtain the views of the public on key barriers to innovation and the need for a new regulatory framework to accelerate the development, safe deployment and industrial uptake of advanced materials. The public consultation was launched by the European Commission through the 'Have Your Say' portal. It was conducted in all EU official languages and was open from 21 October 2025 to 13 January 2026.

Profile of respondents

As shown in Figure 10, the **public consultation survey** received **187 responses.** Most respondents were from academic and research institutions (40.1%) and companies or business organisations (25.1%). Only 9.6% of respondents were from business associations. Citizens contributed at comparable levels, with EU citizens accounting for 12.3% of responses and non-EU citizens 0.5%. Public authorities accounted for 4.3%, NGOs for 2.1%, and 'other' respondents for 5.9%.

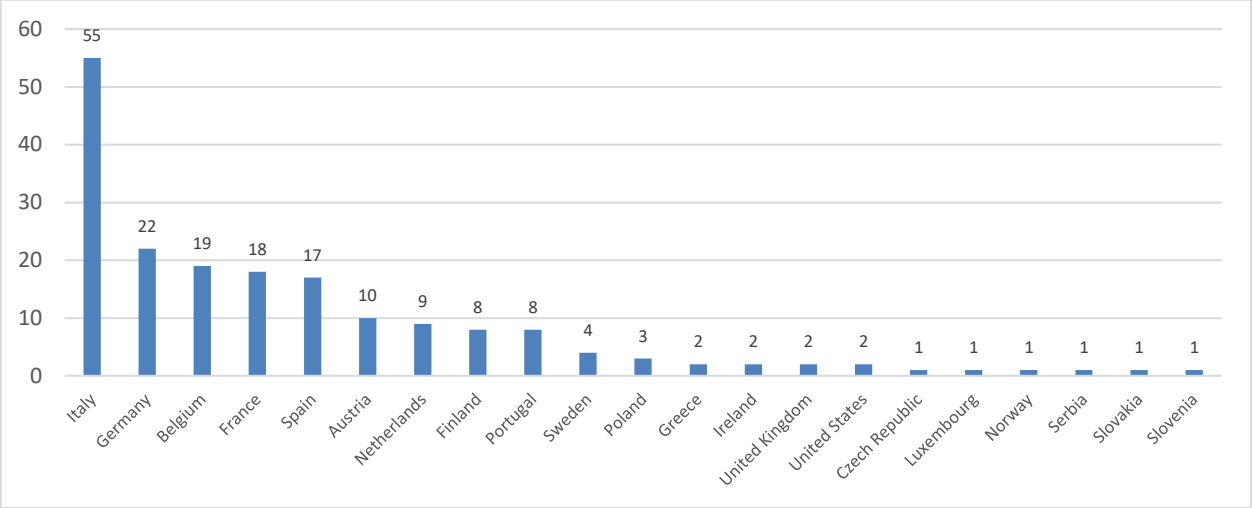
Figure 10. Number of respondents by organisation type



Overall, the response was balanced between research and industry stakeholders (the latter including both companies/business organisations and business associations).

Figure 11 below shows how respondents were distributed across a total of **21 countries**, including **17 EU countries** and **4 non-EU countries**.

Figure 11. Number of respondents per country



Main Findings

When asked whether the scope of the **OECD's working description** of advanced materials[186] is **too broad**, **appropriately focused** or **too narrow**, most respondents considered it to be appropriately focused. Nearly two thirds selected this option, representing 64% of all respondents. A further 27% of respondents felt that the definition was too narrow.

When asked which sectors they expected to generate the **greatest demand for advanced materials** over the next 10 years, expectations were strongest for **sustainable mobility**, with 93% of respondents indicating 'high' or 'very high' demand. **Renewable and low-carbon energy** followed closely, at 92% of respondents.

High demand was also anticipated for **sustainable electronics** (by 85% of respondents), while for **aerospace and defence, including dual use**, 81% of respondents selected 'high' or 'very high' demand. While still representing substantial majorities, expectations were comparatively lower for **sustainable construction** and **medical devices**, at 72% and 70% respectively.

When asked where advanced materials will have the **highest impact on sustainable competitiveness**, **sustainable mobility** again stood out, with 93% of respondents anticipating a high or very high impact. **Renewable and low-carbon energy** were also favoured strongly, with 90% of respondents selecting those two options.

Other sectors were viewed as important, but comparatively less so. **Sustainable electronics** was selected by 82% of respondents, while **aerospace and defence, including dual use** was selected by 75%. **Sustainable construction** followed closely at 73%. **Medical devices** were viewed as the least important among the sectors listed, though still backed by a clear majority (65%).

Respondents were asked to select their **top five obstacles** to ensuring the availability of advanced materials for a clean and competitive industry. **Strategic dependencies of the EU on limited and concentrated supply chains** was selected by 68% of respondents, followed by the **regulatory burden and lengthy qualification procedures and/or lower regulatory burden in other regions** (60%). A further 52% of respondents highlighted **missing links between academic research and industry needs**.

Capacity and enabling conditions were also frequently cited. **Lack of production capacity** was cited by 46% of respondents, and **lack of testing and experimenting facilities for advanced**

[186] See https://one.oecd.org/document/ENV/CBC/MONO(2022)29/en/pdf.

materials by 42%. Beyond these top-ranked barriers, respondents pointed to cost and market structure factors, including **high energy costs** (33%) and **lack of circularity and sustainability** (32%). **Fragmentation of the European market** and **insufficient private sector demand** were each cited by 28% of respondents, while **lack of a 'Buy European' approach** and **lack of a skilled workforce** were cited by 24% and 23%, respectively. Fewer respondents pointed to **insufficient public sector demand** (10.7%), **lack of digitalisation and/or cybersecurity** issues (9.1%) or **lack of restrictions on exports to non-EU countries** (2.7%). Only 0.5% of respondents provided no answer.

Business respondents placed greater emphasis on **regulatory burden and lengthy qualification procedures and/or lower regulatory burden in other regions** than on **strategic dependencies of the EU on limited and concentrated supply chains**, whereas a majority of all respondents ranked supply chain dependencies higher. In addition, business stakeholders considered **missing links between academic research and industry needs** notably less important than respondents overall, at **28%** of respondents compared to **52%.** A further distinction is that business respondents were more likely to flag demand-related barriers, with **insufficient private sector demand** cited more frequently among business stakeholders than in the overall sample.

Respondents were asked to select the **top five regulatory actions** they considered most effective for boosting innovation and encouraging the uptake of new technology in advanced materials. **European collaborative programmes** (such as Horizon Europe Pillar II) were most frequently selected, by 76% of respondents. This was followed by **regulatory support** (including tax incentives, accelerated certification, product validation and permitting processes), which was cited by 64% of respondents.

Measures supporting the translation and scale-up of innovation also ranked highly. **Technology transfer support** was selected by 57% of respondents, while **financial investment to scale up companies** was chosen by 53%. **National or regional collaborative R&I projects** were similarly favoured, with 51% of respondents selecting this option. A second tier of actions received endorsement from around one third of respondents, including **incubators and accelerator programmes** (36%) and **standardisation and certification** (35%). By contrast, procurement-related actions were less frequently selected, with **support to private procurement** cited by 28% of respondents and **public procurement** by 24%. **Integration of the EU Single Market** was selected by 23% of respondents. No respondents chose 'no answer'.

Survey participants were also asked to identify the **top three options** they considered most effective for stimulating demand for advanced materials. Overall, measures aimed at incentivising uptake and reshaping procurement practices were favoured. The most frequently selected option was **incentives for the private sector to use European advanced materials**, favoured by 67% of respondents. This was followed by calls to **introduce procurement criteria that support sustainable advanced materials instead of focusing on lowest price** (56%).

A second group of options attracted support from around half of respondents. '**Buy European' criteria for advanced materials** was chosen by 47% of respondents, while **setting targets for advanced materials used by public entities** was selected by 45%. Measures aimed at private entities were favoured less often, with 23% of respondents selecting targets for advanced materials used by private entities. Still fewer respondents supported more coordination-focused approaches, including **organising joint procurements** (14%) and **creating stocks** (4.8%). A small minority of 5.9% of respondents provided no response.

Respondents were asked to select the **top three sectors** with the highest potential to integrate new circular business models for advanced materials. The results suggest that circularity is expected to be most relevant in sectors closely linked to the green transition and large-scale material flows. **Sustainable mobility** was selected most frequently, with 78% of respondents identifying it as a leading sector for integrating circular business models. **Renewable and low-carbon energy** also ranked highly, cited by 71% of respondents.

A second cluster of sectors attracted more moderate support. **Sustainable construction** was selected by 56% of respondents, while **sustainable electronics** was cited by 45%. By contrast, relatively few respondents (17%) pointed to **space and defence, including dual use**, and still fewer (15%) to other sectors. **Medical devices** was selected least often, by just 14% of respondents. No respondents selected 'no answer'.

The next question focused on whether EU and national regulations affecting advanced materials, for example in relation to safety and environmental aspects, influence market access for new advanced materials. The results point to a strong perception that regulatory barriers hinder market entry. A clear majority of respondents (61%) indicated that **current regulations are overly complex and hinder market access**. In addition, 57% of respondents identified **lengthy qualification, certification and/or permitting procedures** as a key constraint, reinforcing the view that the time and administrative burden associated with compliance can slow down uptake.

Concerns about fragmentation were also prominent. Just over half of respondents reported that a **lack of regulatory coordination among Member States hinders market access**. By contrast, relatively few respondents (14%) described the regulatory framework as neutral, while only 1.1% considered regulations to be innovation-friendly and facilitating market access. A further 14% provided no answer.

Respondents were also invited to **provide their assessment** of how EU and national regulations affect market access for new advanced materials. Those who responded **describe regulation as complex, fragmented and slow**, with bottlenecks in qualification, certification and permitting procedures that delay pilot projects, scale-up and EU-wide market access, particularly for SMEs. A recurring theme is the lack of harmonised EU-wide standards and testing methods, along with **inconsistent definitions across regulations**, gaps in testing guidelines for emerging materials and divergent national interpretations, all of which creates uncertainty, duplicates costs and prevents the emergence of an EU-wide market.

When asked to select the most important impacts for **strategic projects** focused on production and deployment, respondents put the strongest emphasis on competitiveness and supply chain resilience. Boosting the competitiveness of European industries was selected by 59% of respondents, while 49% selected boosting the resilience of European supply chains. Ensuring security of supply for priority applications was also a key consideration, with 33% of respondents selecting securing availability of advanced materials for critical sectors.

Among business stakeholders, competitiveness and supply chain resilience were even more strongly prioritised, with boosting the competitiveness of European industries selected by 69% of respondents and boosting the resilience of European supply chains by 52%. Business respondents also placed comparatively greater emphasis on market-oriented impacts, notably creating circular business models (31%) and attracting investments (29%). Academic and research stakeholders likewise prioritised competitiveness (57%) and resilience (48%), but were more likely than industry stakeholders to highlight enabling conditions for deployment, particularly improving access to advanced materials (33% vs 21.5% among business respondents) and developing the necessary skills and human capital (27% vs 9.2%). They also more frequently emphasised reducing risks by involving technology providers and users (27% vs 17%).

The survey then examined the relevance of **regulatory sandboxes**, intended to enable regulatory learning in cooperation with competent authorities, for bringing advanced materials to market. The response pattern indicates broad support for this tool. Combining the top two levels of support, 73% of respondents considered regulatory sandboxes 'very relevant' or 'relevant', with 35% selecting 'very relevant' and 37% selecting 'relevant'. A further 15% of respondent took a neutral position. No respondents considered this option 'not relevant'. In addition, 7% indicated that they did not know, and 5.3% provided no answer.

Disaggregated results show broadly consistent patterns across respondent groups. Among business respondents, including SMEs, and associations, 73% of respondents rated regulatory sandboxes 'very relevant' or 'relevant', with 42% selecting 'very relevant' and 31% selecting 'relevant'. A further 14% took a neutral position, 4.6% indicated that they did not know and 9.2% provided no answer, while no respondents considered the tool 'not relevant'. Among academic and research institutions, 75% of respondents rated regulatory sandboxes 'very relevant' or 'relevant', with 35% selecting 'very relevant' and 40% selecting 'relevant'. Neutral responses accounted for 16%, while 8% reported that they did not know and 1.3% provided no answer. No respondents selected 'not relevant'. Compared with academia, businesses and associations showed a higher share of 'very relevant' responses (42% vs 35%) and a markedly higher non-response rate (9.2% vs 1.3%), whereas academic and research respondents more often selected 'relevant' (40% vs 31%) and 'don't know' (8% vs 4.6%).

Survey respondents were also asked to select their top five measures to better **monitor and address potential and actual shortages** of advanced materials. Overall, the strongest support was for upstream, system-level actions to improve strategic oversight. Defining critical advanced materials was selected by 75% of respondents, closely followed by the option to carry out vulnerability analysis of supply chains, which was selected by 71%. A second tier of measures focused on preparedness and coordinated action. More than half of respondents (54%) supported building stocks at European or national level, while organising joint procurements was chosen by 46%. Around one quarter selected more interventionist options in response to shortages, including priority-rated orders requiring companies to serve the European market first (28%), and procurement on behalf of Member States (27%). Company-level monitoring measures were favoured less frequently, including requiring companies to monitor potential shortages (21%), requiring companies to report on shortages (13%), requiring companies to monitor stocks (13%) and building stocks at company level (13%). A small minority answered 'don't know' (5.3%) or provided no answer (2.7%).

Disaggregated results point to both common priorities and notable differences between respondent groups. Among business respondents, including SMEs, and associations, the most frequently selected measures were carrying out vulnerability analyses of supply chains (75% of respondents) and defining critical advanced materials (72%), followed by organising joint procurement (48%). However, support for building stocks at European or national level was lower in this group (35%). More interventionist options received more limited support, including procurement on behalf of Member States (29%) and priority-rated orders requiring companies to serve the European market first (23%). Relatively small shares of respondents selected measures centred on company-level monitoring and reporting, including requiring companies to report on shortages (14%), building stocks at company level (14%), requiring companies to monitor potential shortages (7.7%) and requiring companies to monitor stocks (6.2%). Only 4.6% of respondents answered 'don't know'.

Among academic and research institutions, the top priorities were similarly focused on strategic oversight, with defining critical advanced materials selected by 76% of respondents and vulnerability analysis by 75%. In contrast to businesses and associations, this group placed much greater emphasis on preparedness through public stockpiling, with building stocks at European or national level supported by 73% of respondents. Organising joint procurements also enjoyed considerable support (49%). Academic and research respondents were more likely than businesses and associations to favour interventionist and monitoring measures, including priority-rated orders (37%) and requiring companies to monitor potential shortages (28%). They also more frequently selected company-level monitoring and reporting requirements (monitor stocks: 16%, report shortages: 16%), although support for building stocks at company level remained relatively low (9.3%). Only 2.7% of respondents answered 'don't know'.

The survey then examined which types of incentives would be most effective in encouraging the uptake of advanced materials that support **circularity and sustainability**. Respondents most often favoured incentives that directly support innovation and design changes. R&I incentives were

selected by 72% of respondents, followed by design for recycling incentives (65%). Reuse and refurbishment incentives were selected by 46% of respondents. Financial and scheme-based mechanisms also received substantial support, including bonus schemes for circular solutions (36.4% of respondents) and tax credits (35%). Close-loop production subsidies and increased incentives through State aid were each selected by 32% of respondents. By contrast, fewer respondents favoured framework or procurement-related measures, with green taxonomies selected by 14% of respondents and procurement bonuses by 13%. A small minority selected 'other' (6.4%), and 2.7% provided no answer.

Disaggregated results highlight differences in emphasis between respondent groups. Among business respondents, including SMEs, and associations, the most frequently selected incentives were R&I incentives (63%) and design for recycling incentives (55%). Businesses and associations also placed relatively strong emphasis on market-facing financial mechanisms, including bonus schemes for circular solutions (43% of respondents) and both close-loop production subsidies and tax credits (each 37%). By contrast, reuse and refurbishment incentives were selected by just 29% of respondents. Procurement bonuses and increased incentives through State aid were each selected by 23% of respondents, while green taxonomies were selected by 17%. Other options were selected by 14% of respondents.

Among academic and research institutions, respondents favoured upstream incentives even more strongly, with R&I incentives selected by 83% of respondents and design for recycling incentives by 65%. In addition, this group placed substantially greater emphasis on reuse and refurbishment incentives (60%), suggesting a stronger focus on downstream circularity and life extension. Tax credits were favoured by 33% of respondents, while bonus schemes for circular solutions and increased incentives through State aid were each selected by 32%. Close-loop production subsidies were less frequently selected than among businesses and associations (23%). Green taxonomies attracted a similar level of support (17%), while procurement bonuses were rarely favoured (6.7%). No academic or research respondents selected 'other'.

The survey also considered whether **investing in technology infrastructures and testbeds** would be an effective way to reduce time to market for new advanced materials in Europe. Grouping together the two positive categories, 88% of respondents rated this measure 'very effective' or 'effective', with 43% selecting 'very effective' and 45% selecting 'effective'. Only 6.4% selected 'neutral', while 0.5% considered it 'not effective'. Small minorities reported that they did not know (1.1%) or provided no answer (3.7%).

Among business respondents, including SMEs, and associations, 85% rated the measure 'very effective' or 'effective', with 29% selecting 'very effective' and 55% selecting 'effective'. Neutral responses accounted for 7.7%, while 1.5% reported that they did not know and 6.2% provided no answer. No respondents selected 'not effective'. Among academic and research institutions, support was even stronger, with 93% of respondents rating the measure 'very effective' or 'effective' ('very effective': 58%; 'effective': 35%). Neutral responses accounted for 4%, and 2.7% provided no answer. No respondents selected 'not effective' or 'don't know'.

On the importance of establishing **links to national research and technology infrastructures** as part of a digital infrastructure for R&I on advanced materials, responses were strongly positive. Grouping the two positive categories, 85% of respondents rated these links 'very important' (35%) or 'important'(49%). A further 9.6% took a neutral position, while only 0.5% considered this factor 'not important'. In addition, 2.7% of respondents answered 'don't know', and 2.7% provided no answer.

Disaggregated results show the same overall direction of travel, with differences in intensity. Among business respondents, including SMEs, and associations, 77% rated establishing these links 'very important' or 'important', with 23% selecting 'very important' and 54% selecting 'important'. Neutral responses accounted for 14%, while 4.6% answered 'don't know' and 4.6% provided no answer. No respondents selected 'not important'. Among academic and research

institutions, support was stronger, with 91% selecting ‘very important’ or ‘important’ (‘very important’: 39%; ‘important’: 52%). Neutral responses accounted for 9.3% of respondents, with no respondents selecting ‘not important’ or ‘don’t know’ or not answering.

The survey further asked whether increasing joint public and private investments, for example through **partnerships**, would help reduce time to market for new advanced materials in Europe. Grouping together the two positive categories, 87% rated this approach ‘very effective’ or ‘effective’, with 49% selecting ‘very effective’ and 38% selecting ‘effective’. Only 5.3% took a neutral position. Very few respondents considered this option ‘not effective’ (1.1%). In addition, 2.7% answered ‘don’t know’, while 3.7% provided no answer.

Among business respondents, including SMEs, and associations, 91% rated increased joint public and private investments ‘very effective’ or ‘effective’, with 40% selecting ‘very effective’ and 51% selecting ‘effective’. Neutral responses accounted for 3.1%, and 6.2% of respondents provided no answer. No respondents selected ‘not effective’ or ‘don’t know’. Among academic and research institutions, 87% selected ‘very effective’ or ‘effective’, including 55% selecting ‘very effective’ and 32% selecting ‘effective’. Neutral responses accounted for 8%, while 2.7% selected ‘don’t know’, and 2.7% provided no answer. No respondents answered ‘not effective’.

ANNEX 2: CONSULTATION MEETINGS

Several meetings with stakeholders were held to obtain input, ideas and further evidence for the preparation of the proposed Council Recommendation on Advanced Materials [Advanced Materials for Europe] to supplement the expertise collected through the open public consultation and the call for evidence described in Annex 1.

A consultation meeting with several SMEs in the field of advanced materials that are beneficiaries of funding from the European Innovation Council was held on 5 November 2025 to discuss barriers in the advanced materials value chains. Points raised included the need for partnerships between SMEs and industry, simplification of the regulatory framework, skills deficits, strategic dependencies and access to experimental facilities.

A workshop entitled 'Future of Advanced Materials Europe (FAME)' was held in Aveiro, Portugal, on 26-27 November 2025. It took place at the initiative of the Technology Council on Advanced Materials, building on the report of the 'Uptake and Deployment'[187] subgroup. The event featured representatives from Member State governments, industry, academia and venture capitalists, and included presentations on test methods and safety, the Malta Initiative, ISO standard setting, the Advanced Materials Academy, investment schemes, technology infrastructures, regulatory sandboxes and innovation ecosystems. A detailed summary of the outcomes of this event was subsequently published in Nature Materials (Vilarinho, 2026).

A reality check workshop on advanced materials was held on 24 March 2026 to gather input and feedback for the preparation of the proposal with participants from 14 SMEs and industrial actors. The participants discussed the main obstacles facing Europe's advanced materials industrial ecosystem, notably strategic dependencies, limited production capacity, high scaling-up costs, regulatory complexity, costly and slow certification and permitting, fragmented value chains, and weak links between academia and industry. In the breakout sessions, contributors called for faster and more coherent regulatory and certification procedures, stronger SME support frameworks, more demand-driven research and innovation, better visibility and access to research and technology infrastructures, and measures to strengthen circularity and global competitiveness. The workshop also highlighted possible solutions, such as regulatory sandboxes, one-stop advisory services, proof-of-concept validation support, market pull instruments, and stronger coordination to reduce fragmentation and accelerate time to market for advanced materials in Europe.

Input was also gathered through the Partnership on Innovative Advanced Materials for Europe (IAM4EU). For example, focus group meetings with a number of European companies that represent users and producers of advanced materials were organised on 26 March 2026 and 16 April 2026, with the support of IAM-I[188]. The meetings focused particularly on time to market and the advanced materials ecosystem. Key points raised by producers were, for instance, the need to de-risk the 15-year phase from discovery to deployment, regulatory clarity, access for SMEs to

[187] See https://research-and-innovation.ec.europa.eu/document/download/9c492ad5-2c39-4d7c-a6cc-036828ea532a_en?filename=uptake-deployment-advanced-materials.pdf.
[188] https://iam-i.eu – see Section 3 for background.

infrastructures, and the importance of the ecosystem that links large enterprises with start-ups that bring innovative solutions.

Validation workshops were organised for studies carried out to support the preparation of the proposed Council Recommendation on Advanced Materials for Europe, including on the production and use of advanced materials (European Commission, 2026e), the patent landscape (European Commission, 2026d), the landscape of research and technology infrastructures (European Commission, 2026a), and the substitution potential of critical raw materials. Some of these studies also included dedicated surveys[189]. For instance, the validation workshop on the supporting study on the patent landscape was held on 3 June 2026, with 50 external participants from 20 Member States, representing universities, public authorities and companies. The overall focus of the workshop was on strengthening Europe's advanced materials ecosystem, with discussions focusing on key challenges such as value chain dependencies, the gap between innovation and market deployment, and ecosystem fragmentation. Participants discussed possible solutions, including voluntary EU-level monitoring mechanisms, better access to testing and research infrastructures for SMEs and start-ups, support for self-driving labs and digital R&I infrastructures, stronger industry-academia collaboration, improved skills development benefiting from the European Advanced Materials Academy, and demand-side measures such as procurement, standards and sourcing incentives. During the discussions, repeatedly mentioned priorities were speed, reduced bureaucracy, better coordination, and ensuring that Europe can translate research excellence into industrial competitiveness and market uptake more effectively.

Meetings in the context of the Technology Council for Advanced Materials also provided input from Member States, industry and representatives from academia. For instance, the meeting held on 14 April 2026 discussed possible approaches to increase production capacity and reduce time to market, and to gaps and dependencies in value chains.

Discussions were also held with the experts who had prepared the Scientific Opinion on Advanced Materials by the Scientific Advice Mechanism (SAM), which was handed over to the European Commissioner for Startups, Research and Innovation, Ekaterina Zaharieva, on 21 April 2026. This opinion was supported by the evidence report on advanced materials submitted by the Science Advice for Policy by European Academies (SAPEA, 2026).

[189] This included a company survey that received 280 responses from advanced materials users and producers carried out as part of the 'production and use' study (European Commission, 2026e), as well as a survey of research and technology infrastructures that work on advanced materials, which received 144 replies in relation to R&I services, funding models and access conditions, as part of the 'Study on the Uptake of Advanced Materials - Mapping and analysing the role of the European Research and Technology Infrastructures focused on Advanced Materials' (European Commission, 2026a).

ANNEX 3: OVERVIEW OF NATIONAL POLICIES ON ADVANCED MATERIALS

Austria has a well-developed R&I policy and ecosystem that support the production and uptake of advanced materials. Funding is provided via R&D programmes, such as the Austrian Science Fund's (FWF) Cluster of Excellence, FFG Basic programmes and thematic programmes on key enabling technologies, manufacturing and circular economy, Christian Doppler Laboratories and competence centres. In January 2026, the Austrian Government published its Industrial Strategy 2035 and defined advanced materials as one of nine key technologies and strengths, alongside chips, AI, quantum technologies and photonics, manufacturing and robotics, biotechnologies, energy and environmental technologies, mobility technologies, and space and aviation technologies. The ATIMA[190] network has as its goal to build up a cohesive, collaborative advanced materials ecosystem across Austria by leveraging the strengths of multiple regional clusters and existing networks and initiatives and to create strong interfaces with European platforms. Internationalisation of R&D in advanced materials is implemented, for instance, through participation in initiatives such as M.ERA-Net and the candidate IPCEI on circular advanced materials.

Belgium supports advanced materials through its regional innovation ecosystems. In Flanders, it is embedded in a broader industrial and innovation policy involving strategic research centres like IMEC and VITO, Flanders Make, and Strategic Initiative Materials (SIM). Wallonia primarily addresses advanced materials through its smart specialisation strategy (S3), in particular the 'Circular Materials' innovation domain and 'Innovations for Agile and Safe Production'. Belgium participates in the candidate IPCEI on circular advanced materials.

Bulgaria supports the development, production and uptake of advanced materials through the Better Science for a Better Bulgaria policy framework and its Innovation Strategy for Smart Specialisation. These policies create the enabling conditions for funding growth, institutional coordination and quality-based resource allocation, through which advanced material-related research is supported under Bulgaria's parallel smart specialisation framework. This enables the country's research system to channel future advanced materials investment through the Executive Agency for Science's mechanisms for coordinating with field ministries and industry.

Croatia promotes advanced materials via its smart specialisation strategy (S3) and the Research Infrastructure Development Roadmap 2023-2027. National capacity is primarily concentrated in the Scientific Centre of Excellence for Advanced Materials and Sensing Devices (CEMS), jointly hosted by the Ruđer Bošković Institute and the Institute of Physics in Zagreb.

For Cyprus, advanced materials are one of the two technology priorities (the other being digital technologies) within the thematic pillar of the national Research & Innovation Strategy 2024-2026. The strategy draws its sectoral priorities from the country's smart specialisation strategy 2030. Applications are focused on circularity and cover sectors such as construction and building maintenance, aerospace, shipping, energy and healthcare.

Czechia embeds advanced materials in the National Research and Innovation Strategy for Smart Specialisation 2021-2027 (National RIS3 Strategy 2022), as a cross-cutting priority. Advanced materials and nanotechnologies are designated as one of six key enabling technologies (KETs) that cut across all specialisation domains. From an institutional point of view, the Advanced Machinery

[190] See https://www.atima.at/.

and Technologies Platform is the organisation which continuously refines domain priorities, including materials R&D.

Denmark has several research and innovation programmes that promote the production and uptake of advanced materials using instruments such as Innovation Fund Denmark, mission-driven green innovation partnerships (Innomissions), the Manufacturing Academy of Denmark and national research funding and participation in Horizon Europe. The industrial uptake of advanced materials is concentrated mainly in the wind energy sector, sustainable and circular materials, high-performance materials for medical devices and lightweight and environmentally friendly materials, in combination with smart manufacturing technologies.

Estonia's policy focus is on deep tech innovation, technology transfer and the deployment of advanced technologies. Estonia participates in the candidate IPCEI on circular advanced materials.

Finland's policy approach is built around complementary instruments, most notably in critical raw materials, battery value chains and semiconductors, which together address the material supply and technology base underpinning advanced materials. Relevant strategies which contribute to the production and uptake of advanced materials in Finland include the National Mineral Strategy, the National Battery Strategy 2025 and the 'Chips from the North' Semiconductor Strategy. Finland participates in the candidate IPCEI on circular advanced materials.

In France, materials policy cuts across a layered architecture of investment plans, legislation, regulatory frameworks and sector governance bodies, which together shape the field. The dominant instrument is the investment plan France 2030. Advanced materials are addressed through a series of National Acceleration Strategies (*stratégies nationales d'accélération*, or SNAs) and associated Priority Research Programmes (*Programmes et équipements prioritaires de recherche*, or PEPRs), targeting the full value chain from fundamental research (TRL 1-4) to industrial deployment. France's approach is based on strong public investment concentrated in research and early-stage innovation, an industrial sovereignty rationale (particularly on critical materials and batteries) and a cross-sectoral framing that embeds advanced materials within broader transitions in energy, mobility, construction and the circular economy.

Germany has a well-developed and structured approach to advanced materials, with dedicated programmes and initiatives that are referenced in the Federal Government's comprehensive High-Tech Agenda Germany. Mat2Twin is the operational instrument for advanced materials under the Federal Ministry of Research, Technology and Space (BMFTR). It covers the full value chain, provides a formal KPI framework linked to the United Nations' sustainable development goals (SDGs) and targets the research-to-production gap through materials hubs, materials platforms and a variety of other instruments. The digital integration of projects funded under Mat2Twin is mandatory via Platform MaterialDigital (PMD). Additional support measures for spin-offs (EXIST), SMEs and deep tech companies are provided by the Federal Ministry for Economic Affairs and Energy (BMWE), covering also activities dedicated to lightweight engineering, where advanced materials play a fundamental role.

Greece's approach to advanced materials is embedded in the broader national smart specialisation strategy 2021-2027. Advanced materials fall under one of eight priority areas, among which 'Materials, Constructions and Industry', 'Sustainable Energy, Bio-sciences and Health', and 'Environment and Circular Economy'. The strategy applies a Quadruple Helix governance model involving business, the public sector, research and academia, and civil society. The areas of intervention span the full innovation chain, from 'Production of New Knowledge' and research infrastructures (indicative of lower TRLs) through to 'Link of Research with Production' and enterprise internationalisation (indicative of higher TRLs and production stages).

Hungary has in place a smart specialisation strategy (S3) 2021-2027. It also supports university-industry collaboration and commercialisation projects through various national laboratories and competence centres. Hungary participates in the candidate IPCEI on circular advanced materials.

Ireland supports advanced materials as a cross-cutting technology, addressed through its broader national research and innovation architecture. Ireland's research and innovation strategy is entitled Impact 2030. The national AMBER (Advanced Materials and BioEngineering Research) research centre, funded through Ireland's research funding system and hosted by Trinity College Dublin, is Ireland's flagship advanced materials programme.

Italy addresses advanced materials as a cross-cutting KET embedded within two broader instruments: the national research programme and the smart specialisation strategy. Both operate on 2021-2027 cycles, but under different ministries. Italy supports the full advanced materials value chain, from research and development to industrial production, commercialisation, and adoption across the manufacturing, energy, mobility, aerospace and sustainability sectors. Other policy frameworks also form part of Italy's advanced materials landscape. The National Strategy for the Circular Economy, adopted in June 2022, includes critical raw materials among its areas of intervention and aims to strengthen the market for secondary raw materials as substitutes for virgin materials. It also promotes the development of new materials as a functional replacer, thereby supporting circularity and supply resilience. The 2026-2028 Strategic Guidance Act on the exploitation of knowledge and technology transfer, jointly developed by the Ministry for Universities and Research (MUR) and the Ministry of Enterprises and Made in Italy (MIMIT), further reinforces the link between the public research system and industry, with a view to improving technology transfer and the industrial exploitation of strategic research results. Several strategies contained in the Act refer explicitly to advanced materials. Finally, the National Quantum Strategy identifies quantum simulation as a key quantum technology domain and provides an additional policy context in which the emerging quantum applications can support the development of new enabling materials. Italy participates in the candidate IPCEI on circular advanced materials.

Latvia's advanced materials strategy is embedded within a broader state research programme, the 'Innovation Fund – Sectoral Research Programme'. It targets the field of 'Photonics and Smart Materials, Technologies and Engineering Systems' under the smart specialisation strategy (RIS3), delivered through a single project entitled MOTE ('Smart Materials, Photonics, Technologies and Engineering Ecosystem'). The sector focus is cross-cutting, combining materials science with medical engineering and electronics/ICT, and spanning photonics, microfluidics, smart/functional materials, robotics and the internet of things (IoT).

Lithuania embeds advanced materials as a thematic area within two broader instruments. These instruments are the Research, Experimental Development and Innovation Smart Specialisation Concept, adopted in 2022, and the Lithuanian Industry Digitisation Roadmap 2019-2030, developed by the Ministry of Economy and Innovation. The former makes a direct link to advanced materials as it designates 'Advanced Materials and Structures' as an explicit thematic area under Priority 2 ('New Manufacturing Processes, Materials and Technologies'), alongside photonics, laser technologies, flexible manufacturing, energy efficiency and renewable energy. Lithuania participates in the candidate IPCEI on circular advanced materials.

Luxembourg's approach to advanced materials is to include them as a sub-domain in the country's broader National Research and Innovation Strategy. This strategy instrument was adopted by the Government in January 2026, building on the original strategy approved in December 2019. Overall, Luxembourg actively supports advanced materials innovation, commercialisation and industrial adoption through a combination of national research priorities, innovation agency support, collaborative infrastructures, and strong integration into European initiatives.

In Malta, advanced materials are embedded within the broader Malta smart specialisation strategy (RIS3) 2021-2027, developed under the technical leadership of the Malta Council for Science and Technology (MCST, now operating as Xjenza Malta). The strategy serves as the national research and innovation planning instrument. Advanced materials also fall within several of the strategy's six priority areas: (i) composite materials are mentioned under the Aviation and Aerospace priority; (ii) new and existing materials for solar panels and lightweight composites are mentioned under 'Sustainable Use of Resources for Climate Change Mitigation and Adaptation'; (iii) biodegradable materials for medical devices are mentioned under 'Health and Well-being'; and (iv) exploration of new raw materials is mentioned under 'Smart Manufacturing'.

The Netherlands pursues advanced materials through a layered, mission-driven system. The Dutch Materials Agenda (2020) and a discipline-specific roadmap (Chemistry for Advanced Materials, ChemistryNL) feed into a top-down, government-backed funding covenant (Kennis- en Innovatieconvenant, KIC 2024-2027) that allocates public-private money with a focus on fast market deployment. ChemistryNL's Roadmap is the most detailed instrument relating to advanced materials. It translates its ambitions into three tasks: (i) materials with added functionality, (ii) thin films and coatings, and (iii) materials for sustainability. Energy Materials is one of ten priorities set out in the Dutch National Technology Strategy (NTS). Under the NTS priorities 'Semiconductor Technologies' and 'Process Technologies', materials innovation related to those technologies is a focus area. Advanced materials have therefore been incorporated in the action agendas related to the NTS. Advanced materials have been identified as a strategic growth market under the industrial policy on innovative chemistry.

Poland currently has no specific programmes for advanced materials, but supports public investment in R&I, with a focus on photonics, nanoelectronic materials, functional materials, and strategic autonomy in raw materials. Poland participates in the candidate IPCEI on circular advanced materials.

Portugal addresses advanced materials mainly through broader research, innovation and industrial policy frameworks, as opposed to a dedicated national strategy. The main reference is Estratégia Nacional de Especialização (ENEI) 2030, where 'Materials, Systems and Production Technologies' is one of six priority domains, complemented by regional smart specialisation strategies. Implementation is supported through Portugal 2030 and the Mobilising and Green Agendas funded under the Recovery and Resilience Facility (RRF). The National Energy and Climate Plan (PNEC 2030) provides a sectoral framework for energy-related applications. Recent initiatives on critical raw materials further strengthen the value chain dimension and existing links with European industrial resilience objectives. In parallel, the National Strategy for Emerging Technologies (ETE), coordinated by the government body PLANAPP in cooperation with the National Innovation Agency (ANI) and the Foundation for Science and Technology (FCT), is expected to provide a more future-oriented framework for advanced materials, identifying strategic priorities for investment, research and innovation, and strengthened collaboration between the scientific, technological and business communities. Portugal participates in the candidate IPCEI on circular advanced materials.

Romania embeds advanced materials in the National Strategy for Research, Innovation and Smart Specialisation 2022-2027 (Strategia Națională de Cercetare, Inovare și Specializare Inteligentă, SNCISI), as one of seven national smart specialisation fields. Within SNCISI, advanced materials feature explicitly as Smart Specialisation Field 'Advanced Functional Materials', which comprises six subfields: (i) optoelectronics; (ii) smart composite materials; (iii) recyclable materials and material recycling technologies; (iv) materials for electronic, electrical, photonic, magnetic and

sensor applications; (v) biocompatible materials; and (vi) materials for energy. Advanced materials also feature as a cross-cutting theme in the Strategic Research Agenda.

In Slovakia, advanced materials are embedded as a cross-cutting theme within the Research and Innovation Strategy for Smart Specialisation of the Slovak Republic 2021-2027 (SK RIS3 2021+). The primary sectoral focus for advanced materials is under 'Innovative Industry for the 21st Century', specifically under 'Progressive Technologies and Materials', which covers nanomaterials, smart materials, biomaterials, biotechnologies, and breakthrough/completely new technologies. Advanced materials are also mentioned under zero-emission vehicles, nanomaterials and biomaterials for healthcare, as well as biomass-based materials and circular bioeconomy.

Slovenia embeds advanced materials in its smart specialisation strategy, under 'Materials and End Products'. Focus areas include steels and special alloys, aluminium, multicomponent smart materials, and functional coatings and binders. Advanced manufacturing technologies for materials (including nano and quantum) are also a cross-cutting key enabling technology under the Factories of the Future horizontal network. The sector focus is explicitly industrial: steels and special alloys, aluminium, manufacturing and recycling technologies, multicomponent smart materials, functional coatings and advanced binders. The approach spans the entire RDI-to-market chain, focusing on materials for complex high-value products with global value chain potential, pilot centres and industrial upscaling, rather than basic research alone. Slovenia participates in the candidate IPCEI on circular advanced materials.

In Spain advanced materials are embedded in the Strategy for Science, Technology and Innovation (2021-27) and other sectoral strategies, including the Plan de Acción de Materias Primas Minerales 2025-2029 and the Estrategia España Circular 2030. They are funded by a wide portfolio of mostly bottom-up instruments, covering all TRLs. In recent years, Spain has launched a dedicated advanced materials programme and a structured set of complementary instruments that together constitute a national policy effort in this field. The programme Plan Complementario de Materiales Avanzados, formally entitled 'Materiales con Funcionalidades Avanzadas para la Nueva Transformación Tecnológica (2021-2025)', has funded over 70 research projects across thematic areas covering graphene and 2D materials, energy materials, and smart functional materials for health, ICT and mobility. Spain further reinforces its materials ecosystem through a set of sectoral instruments with significant links to advanced materials, such as strategic projects for economic recovery and transformation (PERTE) programmes, dedicated to semiconductors and microelectronics, aerospace and cutting-edge health technology. Spain participates in the candidate IPCEI on circular advanced materials. Spain participates in the candidate IPCEI on circular advanced materials.

In Sweden, advanced materials are addressed through Strategic Innovation Programmes (SIPs), a portfolio of 17 sector-specific public-private partnerships launched in 2013 under a mandate set out in the 2012 Government Research and Innovation Bill. The programmes operate on the basis of competitive calls for R&I projects, strategic projects and complementary activities, with management outsourced to consortia governed by elected boards. The materials-relevant SIPs are BioInnovation (bio-based materials, with EUR 52.2 million granted between 2015 and 2026), Metallic Materials (metals industry, with EUR 37 million granted in the first six years), LIGHTer (lightweight design, with EUR 17 million granted to date), SIO Grafen (graphene and 2D materials, with EUR 10 million granted to date), and RE:Source (circular material flows, with EUR 22 million granted to date). The 2024 Research & Innovation Bill establishes advanced materials as a new strategic research area, with the objective of building internationally competitive research environments and strengthening industrial competitiveness. In addition, the Wallenberg Foundation has launched the WISE (Wallenberg Initiative Materials Science for Sustainability) research programme, with a budget of around EUR 270 million for the period 2022-2033.

ANNEX 4: LIST OF ABBREVIATIONS

2D	Two-dimensional
AI	Artificial Intelligence
ATMPs	Advanced Therapy Medicinal Products
BESS	Battery energy storage systems
CEMS	Scientific Centre of Excellence for Advanced Materials and Sensing Devices
CERN	European Organisation for Nuclear Research
CLP	Classification, Labelling and Packaging (Regulation)
CRMs	Critical raw materials
DARPA	Defence Advanced Research Projects Agency
DG	Directorate-General
DIANA	Defence Innovation Accelerator for the North Atlantic
DX	Digital transformation
ECHA	European Chemicals Agency
EIC	European Innovation Council
EIT	European Institute of Innovation and Technology
EMA	European Medicines Agency
EMMC	European Materials Modelling Council
EOSC	European Open Science Cloud
ERA	European Research Area
ERA-NET	European Research Area Network
ERC	European Research Council
ERDF	European Regional Development Fund
ERIC	European Research Infrastructure Consortium
ESCO	European Skills, Competences, Qualifications and Occupations
ESPR	Ecodesign for Sustainable Products Regulation
EVs	Electric vehicles
FAIR	Findable, Accessible, Interoperable, Reusable
FAIR+	FAIR, including additional safeguards for responsible data governance

GDP	Gross domestic product
I3	Interregional Innovation Investments
IAM-I	Innovative Advanced Materials Initiative
IAM4EU	Innovative Advanced Materials for Europe (Partnership)
ICT	Information and communication technology
IMERA	Internal Market Emergency and Resilience Act
IP	Intellectual property
IPCEI	Important Project of Common European Interest
ITAR	International Traffic in Arms Regulations
IoT	Internet of Things
KET	Key Enabling Technology
KPI	Key performance indicator
MFF	Multiannual Financial Framework
MRI	Magnetic resonance imaging
NAMs	New Approach Methodologies
NATO	North Atlantic Treaty Organization
NGOs	Non-governmental organisations
NSC	Nano Safety Cluster
OECD	Organisation for Economic Co-operation and Development
OLEDs	Organic light-emitting diodes
P2X	Power-to-X
PARC	Partnership for the Assessment of Risks from Chemicals
PET	Positron emission tomography
PFAS	Per- and polyfluoroalkyl substances
PMD	Platform Material Digital
RAISE	Resource for AI Science in Europe
RAMP	Raw Materials Partnership
RDI	Research, development and innovation
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RI	Research infrastructure
RI&TI	Research and technology infrastructure
RIS3	Research and Innovation Strategy/Strategies for Smart Specialisation

S3	Smart Specialisation Strategy
SAM	Scientific Advice Mechanism
SAPEA	Science Advice for Policy by European Academies
SET	Strategic Energy Technology
SIP	Strategic Innovation Programme
SME	Small and medium-sized enterprise
SSbD	Safe and Sustainable by Design (voluntary framework – Commission Recommendation)
STEP	Strategic Technologies for Europe Platform
SWD	Staff Working Document
TI	Technology infrastructure
TRL	Technology Readiness Level
UHPC	Ultra-high-performance concrete
XFEL	European X-Ray Free-Electron Laser Facility