Alliance for Materials

Opinion Paper on Governance and Strategic programming of Materials Research and Innovation in Horizon Europe

February 2019

1. Motivation – setting the stage ("WHO" and "WHY?")

The Alliance for Materials (**A4M**) started almost ten years ago to align the voices of major Materials-related organisations representing Industry, Research and Academia (EUMAT; SUSCHEM, MANUFUTURE, EMIRI, FEMS, EMRS, ETP-SMR, ESTEP, Textile-ETP and NANOFUTURE)[1]. These organisations also collaborated in MATVAL and MATCH EU Projects, supporting EU Commission in **Materials Research, Development and Innovation (R&D&I) Governance.**[2a,b]

Strategic planning is a facilitator and tool to boost innovation, which is more than technology. As pointed out by the Lamy report[2c], to overcome future challenges, in particular to modernize EU industry, EU innovation policy must be based on a definition of **innovation that acknowledges and values all forms of new knowledge** – technological but also business models, financing, governance, regulatory and social – which help generate value for the economy and society and drive systemic transformation. With the basic framework and strategic planning of Horizon Europe (HEU) reaching the decisive phase within the Commission, it is now the right time to share input and opinions from the materials-related stakeholders with the Commission. In the meantime, the need to enhance the involvement of additional materials-related teams (EIT Raw Materials, European Aluminium, ECTP, CFPC, ECP4, EMMC, EMCC, EPPN, ETPN, EDA, CLEPA, KMM-VIN, RISK)[1] became apparent to assure the representation of the complete materials community. These stakeholders will be able **to provide solutions for the needs of materials in the expected challenges and missions of the future**.

It is widely agreed that materials are a key part of the basis of almost every innovation, and raw materials, materials and processes research, to convert material innovations into products is needed (and addressed) in nearly every Horizon Europe Cluster, Mission or Partnership activity. In fact, advanced materials and their manufacturing and processing are the most typical and explicit example for cross-silos, cross-research areas, cross-clustered R&D&I. Therefore, while preserving the needs and peculiarities of the different sectors, we recommend **a problem solving, impact and system-oriented Materials research approach in HEU.** As already foreseen under Cluster 3, the ecosystem approach and the research and innovation should be integrated on the steps for materials development, characterisation, modelling and piloting/upscaling.

Advanced materials will be key enablers to reach policy objectives for sustainable growth, using environmental friendly materials, facilitating the transition to low carbon footprints and the circular economy. A proper strategy should minimize "**raw materials dependence"** from **outside Europe** while promoting recycling and re-use. Quality benchmarking and fragmented regulation should be

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properly addressed to stimulate innovation and progress, in nano, bio, secondary (recycled) and high performance materials.

Developing **materials and products for durability, energy efficiency and circularity** shall be a key objective, integrating and optimizing material developments into the full product value chain with a life cycle perspective, is essential. Here, we should adopt a **new model to boost disruptive evolutionary development,** targeting the clear needs of end users and market. Therefore, the mission to shape the future must clearly have as a key priority *-materials that are fit-for-purpose and provide improved quality of life for EU citizens*. The impact of materials R&D&I along the value chains can be huge! **A4M** recognises that the synergies between different application areas of materials, the avoidance of double funding, the fundamental materials R&D serving all stakeholders, as well as the balanced funding of cross-cutting challenges, relevant to the whole materials community, requires special (infra-) structures and responsibilities. In one word: **a governance structure for materials R&D&I.**

2. Proposals for Materials Governance in Horizon Europe ("HOW?")

- **A4M** already supports a strong, high-quality, comprehensive materials governance in Horizon Europe.
- The preferred option would be an "entry-point" for materials-related R&D&I challenges, inquiries, proposals, projects directly linked to more than a single specific sector. This should provide an up-to-date and complete overview of any Materials related activities serving multi-sectors as well as linking basic material research in Pillar I, with applied material research in Pillar II.
- A4M welcomes the setting-up of the new EU Commission Unit (F4) within PROSPERITY, i.e. Materials for Tomorrow, and hopes that this Unit would act as the entry point.
- However, as materials research is an important building block in the success of many different clusters, missions and partnerships, the entry point should also assure proper Materials governance "beyond PROSPERITY". A4M advocates for a sort of commission-wide on-line information hub where ALL materials-related programmes and projects would be registered, so that information is efficiently disseminated to interested stakeholders and broadly used, where it best fits.
- Strong materials governance also means supporting the EU Commission in setting new or adapted rules, tools and data bases for the monitoring, sharing and transmission of materials data, project results, and research findings from one thematic area to another, across clusters and missions. It implies not only the possibility to flag (identification and tracking) the different materials activities along the HEU, but also to create a real Open Science approach within the different scientific and technological groups/consortia, active in the programme. Only through an effective on line sharing of knowledge, the progress and results from projects, will it be possible to create cross-cutting benefits, synergies and optimal use of resources, reducing the time to market. For example, we can re-direct the field of material application of an idea/product/system, thereby reducing exploitation cost.
- **A4M** has a vast materials and market experience available through its member organisations, and thus offers to act a materials reference partner to the Commission. **A4M** welcomes the possibility to take an active role in the upcoming Strategic Programming exercise, supporting the Commission in setting up and carrying out Materials Governance and Co-creation in Horizon Europe.

3. Co-creation: systemic approach towards sustainable society, including the citizens ("WITH WHOM?")

Co-creation means the "involvement of all parties", reinforcing synergies with other key-stakeholders such as Pilot Project Partnerships like SPIRE[2d] or Factory of the Future[2e]. A material value chain approach combines "Design, raw materials processing, materials transformation and products manufacturing, their use and recycling" considering both economic and environmental aspects. We should promote sustainable sourcing and value chain from and in Europe, protecting knowledge and exploitation in Europe. We should better integrate materials research within the industrial policy and economic market instruments to reach a coherent and stronger European position globally. We should also promote gender equality, diversity, and involvement of the citizens (beyond "just stakeholders and customers or end users") in research policy, setting and programming priorities definition. This goes far beyond good information and communication actions. Co-creation considers the (societal) needs of the different population groups outside the high-tech community (e.g. groups that don´t easily embrace digital technology, the aging population, children with migration backgrounds, etc..). Their experience, skills and ideas must not be lost.

Co-creation needs robust communication about technology research value and its impact on citizens and it is not new to the **A4M** community. Among these initiatives: a) the plastics industries have widely looked for citizen-oriented problem solutions; b) the KIC EIT Raw Materials works with schools, museums, entrepreneurs, consumer advocates, citizens, policy makers and regulators, promoting creative industries generation based on youth ambitions; c) FEMS is organizing workshops, addressing "materials for solutions of societal problems" targeting different age and experienced groups[2a-b]; d) EMRS is promoting functional materials to decrease systems complexity; e) EuMaT is establishing the use of Social Media to capture a broad spectrum of opinions on materials trends; f) ESTEP is promoting "prizes" winning and is currently involved in the ESSA Project on Skills Agenda and Strategy;[2f] g) The ETP Nanomedicine (ETPN) boosts industrial development of efficient and safe medical applications of nanomaterials; h) the NOBEL Project raises awareness, promoting dialogue for emerging medical technologies to provide smarter healthcare solutions for citizens, by combining biomaterials, medical devices and artificial intelligence along the continuum of care[2g]; i) ECTP is addressing material's use for health, safety and social comfort in the built environment, j) ETP SMR is part of the European Minerals Day initiative that invites children and the public at large to discover the minerals sector's importance to society through open days at industry sites. In general, the wide range of active **A4M** partners and beneficiaries covers already a sizeable part of society.

A genuine co-creation approach must contain a well-managed feedback loop, where citizens can engage in a multilateral dialogue enabling their voices to be considered, in the definition of priorities and in addressing long-term effects of technological changes. **A4M** intends to work with a multi-actor engagement process making use of innovative tools as the one developed in the SwafS Project[2h] on Responsible Research & Innovation to bring together technological, social and human sciences, for early involvement of the citizens in policy decisions; **A4M** welcomes the opportunity to run one or several pilot projects in H2020 and Horizon Europe supporting the Commission in a technology-societal Co-creation process.

4. Relevant Examples ("WHAT?")

Materials R&D&I typically addresses cross-sectorial issues. A first collection of Materials Challenges addressing Sustainable Development Goals (SDG) with explicit communalities and with technology convergence are defined in the following table:

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SDG	The Problem	The material's solution	The Key Enabling technologies	The Impact
13 CLIMATE ACTION	About **29% of the energy consumption** is for transport.[3a]	Light alloys: Al, Mg, high strength steels, composites, plastic formulations	Higher strength/ density functionally graded materials, nanotechnology 3D printing, Joining	A 10% reduction in vehicle weight can result in a 6-8% fuel economy improvement[3a].The value of weight reduction is 870€/kg in aeronautic[3b]
13 CLIMATE ACTION 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	20 % of **all energy produced** worldwide (119EJ, exa-joules) **goes to overcome friction**[4, 13]	Advanced coatings, texturing, low viscous fluids, 2D additives, ionic liquids, bioinspired, H-free DLC, nanoparticles	Tribology (accelerated test at product and process design phase) Infrastructure for testing on line components lifetime	Potential savings with new material solutions: transport (25%), industries & power generation (15%), residential (10%).[4]
13 CLIMATE ACTION 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	The economic losses worldwide due to wear is €684,72Billion[4, 13]	Nanotechnology, 3D printing, additive manufacturing, texturing, advanced coatings, lubricants	Tribology study of durability at design phase (a system approach). Multiscale testing & modelling. Artificial intelligence	Attention to tribological problems would imply worldwide annual savings of €970 Billion (1.39 % GDP)[4]
13 CLIMATE ACTION 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Global **cost of corrosion is 3-4% GDP** (Gross Domestic Product). [5a] How to reduce it?	Advanced coatings, nanotechnology, self- healing coatings, protection, control hydrogen embrittlement	Accelerated corrosion tests advanced materials, modelling Joining challenges Sensors, NDT	Potential to reduce the cost by €761 Billion annually with advanced materials technologies[5b]
13 CLIMATE ACTION	The **thermal energy** losses can represent 50% of fuel consumption[6]	Thermoelectric, phase change material, nanomaterials Super-insulation	Energy efficiency Co-generation Heat exchangers Insulation, energy harvesting	Energy Recovery amounting to 20% in manufacturing sector[6]
13 CLIMATE ACTION	**For Space transport are** necessary materials compatible with atmospheric and vacuum conditions	Novel multifunctional materials (adaptive, self-healing intelligent coatings), exploited at nanoscale High strength/low density	Industry 5.0 outgassing, tribolayers tribodesorption Energy harvesting	Multifunctional material and electronics interfaces for energy transmission.
13 CLIMATE ACTION 14 LIFE BELOW WATER	**88 million tonnes of food waste are generated annually in EU** with a cost of €143 Billion[7a-e]	Packaging and sensors: Biobased materials recyclable/compostable Phase change materials Surface texturing	Antimicrobial Smart surfaces Biochemistry Biosensors Smart packaging (plastic/paper)	Potential to increase by 50% food shelf life, reduce waste, "food footprint by 2030"[7f]
14 LIFE BELOW WATER	**Oceans** contaminated with plastics. Plastic industry (€350Billion)[8]	Ecodesign for recycling Recycled plastic use in second generation products. Biodegradable and/or biobased plastics	Chemo-mechanical or physical recycling Recycling of mixed plastics Composting Compatibilizers	Potential reduction of carbon footprint by 30%.[8]
14 LIFE BELOW WATER	Need to control and ensure the right water & air quality for all!	Eco-sustainable light activated materials for sensing and anti-pollution applications. Antimicrobial filters, paints, coatings and membranes	Nanotechnology, chemical method based; exploiting 3D laser processing, nanocatalysis and photocatalysis	Full eco-friendly and eco-sustainable smart solutions to control/eliminate pollution
3 GOOD HEALTH AND WELL-BEING	How to increase the **lifetime of implants** and to improve the tissue scaffolds performance in the human body?[9a]	Performing accelerated test at laboratory level Durable Prosthesis with antimicrobial functions Bioactive scaffolds Catalytic membranes	Tribology, coatings 3D Printing, Antibacterial surfaces Nanotechnology Osseointegration Impact, scratch resistance	A prosthesis can cost from 3-50k€. [9b] It should be avoided that the person is operated twice
3 GOOD HEALTH AND WELL-BEING	Defeating **diseases** (eg. cancer and Alzheimer) require drug delivery and precision medicine	Quantum and nano materials, biosensors, biocompatibility Small sensor matrix for Personalized medicine Control drug delivery Bioactive membranes	Nanomedicine Brain analysis, cognitive research, molecular biology Teleassistance, artificial intelligence, modelling Precision medicine Nanomaterials, biomolecules	The health cost in Europe is 10% of the GDP. 18M new cancer cases are diagnosed each year almost 50% of them will be lethal.[10]
12 RESPONSIBLE CONSUMPTION AND PRODUCTION 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Availability of **raw materials** in EU is under concern. **Solution:** Circular economy	Materials for ICTs Secondary materials, reuse Simulation behaviour Circularity, durability and energy efficiency by design dematerialisation Hard tooling (mining) Quality bench-marking	Tracking, sorting, recycling Artificial Intelligence Nanotechnology Modelling & characterization Sensors enabling circular Common regulations Business models (sharing)	20% faster verification and 20% improvement of processing and durability.[11a] Reduce landfill waste by 50%.[11] Potential to reduce 300 million tonnes CO_2 emissions by 2050 with circular economy[11b]

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	During this century the climate change imposes use of **renewable energy for industry, cities and transport**	High strength light weight Solar absorber coatings coatings for reflectors, High TºC resistant thermal fluids. Advanced materials and lubricants for wind energy. Low friction coatings	Wind mills. Concentrated solar thermal, photovoltaics (PV) Geothermal CO_2 capture utilization & storage Hybridization (eg. PV, wind)	85 countries, states or provinces have targets to reach >50% of renewable energy .[12a] EU advanced materials for low carbon energy industries represent a turnover of €30Billion.[12b] Wind and PV has the potential to reach the 50% of the renewable energy.[12c]
	The CO_2 emissions of cities is too high and by 2050, worldwide population will grow 30%[13b]. Batteries are dominated by Asian products and the whole car industry (13 Millions jobs!) is depending on them[12c]	Materials for e-mobility and (batteries, fuel cells, hybrid) Anodes, cathodes, polymer electrolytes, Membranes, catalyst, solid oxide friction materials Low wear materials Nanomaterials, ionic liquids Low viscosity lubricants Energy efficient IC engines	Reduction friction and wear Use of biofuels Use of electrical vehicles Nanotechnology Modelling &characterization Cogeneration Clean coal, Nuclear, fusion Energy efficiency, autonomy Low particulate, CH, CO & NOx emissions	Friction losses in **electric cars** are 48,5% lower than in combustion engine (IC) cars[4] and has nearly no CO_2 emissions during use phase (during production phase is higher).[13a] Share of electrical vehicles (EVs) might reach 30% market share by 2030[13c]
	How to build **energy efficient and citizens** comfortable buildings?	Secondary materials Phase change materials Photocatalytic (Vis-light) Light, antimicrobials Nano-coatings, self-healing, self-cleaning, ceramics tactile properties Anti-slip paving,	Recycling, 3D Printing, sensors. Functional materials & surfaces Building integrated PV Thermal efficiency Renewable energy Prefabrication Tribology, Security	EU estimates that 70% of product innovation across all industries is derived from new materials.[14a] Citizens live 90% of the time indoors, and their comfort can be significantly improved.[14a] Combined heating & power for CO_2-for neutral CO_2 districts[14b]
	Building materials are 1/3 of construction cost with the highest raw materials consume	High durable materials Ceramics, Coatings Nano-reinforced materials Self-healing, self-sensing	Texturing, self cleaning Recycling, reinforce, reuse non destructive testing structural health monitoring	Significant reduction in worldwide consumption of raw materials, increase in safety of infrastructures and buildings.[14a]
	The wind and PV energy needs storage to follow energy demand	EU raw materials use batteries made in Europe batteries (redox flow, other Anodes, Cathodes Electrolytes, cyclability Higher strength/density larger materials production	Materials development Battery management Integration, autonomy Characterization Modelling Hybridization PV-Wind Energy storage + PV or Wind	Moving from fossil fuels to renewable energy will cut down energy loss due to friction >60%. With full renewable energy share, the CO_2 emissions of electric cars could be 78% lower[13]
	Manufacturing needs to go in new ways towards industrialized and rural countries	Advanced functional and smart materials including textiles. Materials for Additive Manufacturing	Individualized, local manufacturing with high-performance Additive manufacturing and smart Materials. 3D printing	Large socio-economic impact; new work & living balance for citizens and cities; new jobs and added value in Europe[15]
	Digitalization also reaches Materials by design	Digital Twin of materials; materials as integral part of I4.0, involving modelling and AI (Artificial intelligence)	New fast Materials characterization & modelling, model-based properties, co-design ontologies	Future Data Market in Europe is €65Billion with expected growth to unless €96Billion[16]
	Product and process development needs to shorter time to market	Modelling and characterization should collaborate closely	Multiscale modelling Multiscale characterization Ontologies, Databases	Reduce time to market by 30% combining modelling and characterization [1apq]
	Quantum Technology reaches our everyday life	New industry-scale materials for quantum devices, for sensors, for quantum computing	Mastering quantum effects, quantum materials by design	Breakthrough developments in health, communications, computing, cryptology ++[17]

Table 1: Examples of current materials R&D&I challenges linked to their key enabling technologies and their impact

5. Implementation ("NEXT?")

- As agreed in the meeting on 29th January, **EUMAT,** The European Platform for Advanced Engineering Materials and Technologies, will **serve and act as secretary** of A4M.
- A4M invites the EU Commission to strongly consider the possibility to support the implementation **of the afore-mentioned A4M activities by** launching **a Coordination initiative** on this theme.

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ANNEX: ENTITIES SUPPORTING THE DOCUMENT

Note: a) Manufuture Platform, agree with the content of the position paper and will act as observer; b) EDA agrees on the content of the Position Paper

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