EurASc Annual Symposium 2025

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CERN

Book of Abstracts

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How to Make Science Practically Useful

Author: Martin Carrier[1]

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The traditional account of making science practically useful goes back to Vannevar Bush's 1945 "Report to the President."This report promoted basic research "performed without thought of practical ends"(Bush 1945, chapter 3) as the linchpin for achieving practical utility. This approach has become known as the "linear model"; it places progress in epistemic or basic research at the center of technological progress. Novel procedures and devices are mostly created by relying on new scientific insights.
The linear model is now generally pronounced dead by economists and sociologists, but examples to this effect can be found. The discovery and use of giant magnetoresistence follows this pattern. However, it became clear in the past half-century that the path from scientific novelty to technological innovation suggested by the linear model was far less fruitful on a broad scale than Bush had imagined.
I suggest that there are three additional pathways of how scientific knowledge may be connected to technological novelty. One is the knowledge-driven mode of use-oriented research. This mode proceeds from existing knowledge. You start with what you know in order to find out what you can do. The invention of gas-discharge tubes or LEDs proceeded on the basis of earlier insights into the interaction of electricity and matter; the invention of liquid crystal displays owed much to earlier research on the effects of electrical fields on liquid crystals and on the properties of polarized light. In most cases, that knowledge needs to be expanded, and that is what practice-driven research seeks to accomplish. But the necessary knowledge-base and scientific understanding are already there beforehand; only the details are missing. No additional basic research spurs such utility-driven endeavors.
Furthermore, some practical achievements are based on mere observational regularities, or are the result of combining existing technology in new ways and thereby create new appliances. The dishwasher or the assembly line were conceived through engineering ingenuity, without consulting the latest advances in basic research. Such novelties are technology-driven, not research-driven. Some technological development proceeds independently of theory so that the spark of creativity does not reach the theory. This is the autonomy-of-technology mode of creating practical devices.
Finally, epistemically significant questions may be tackled within the framework of use-oriented research projects. In such application-innovative research, the fundamental knowledge required for a technological novelty is only generated in the context of practice. Some challenges of practice-driven research cannot be adequately mastered without addressing fundamental questions. Epistemic research is therefore also a –usually unintended –consequence of successful demand-driven research. For instance, the revolutionary concepts of retroviruses and prions were conceived in the context of identifying chains of infection. Application innovation is the temporal inverse of the linear model in that basic research is not the origin of technological development, but emerges at a later stage.
My claim is that basic research is sometimes productive in technological respect (in contrast to more recent claims to the contrary), but that additional modes of making science practically useful exist: knowledge-driven technology development, autonomy of technology, application-innovation.

EURASC Symposium (Session 4) / 4

From a material developed for solar cells applications to innovative helium targets´ fabrication for fundamental nuclear reaction

studies.

Authors: Asunción Fernández[1]; Dirk Hufschmidt[1]; M. Carmen Jiménez de Haro[1]

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The connection between fundamental research and societal applications may play a major role in both directions. In this contribution we present the fabrication and characterization of "solid-gas"nanocomposite films, initially developed for antireflective coatings in solar cells applications. Firstly, it was found that the nanoporous silicon films, obtained by magnetron sputtering (MS) deposition in helium plasma, showed the required reduction of refractive index [1]. The IBA (Ion beam analysis) and TEM-EELS (Transmission Electron Microscopy) techniques showed that the films contained however high amounts of helium trapped inside the nano-pores. The formation of He nano-bubbles was demonstrated [2]. This methodology could also be extended to other matrix elements and to the use of the 3He isotope using a low gas consumption procedure [3]. Helium contents achieved 3.25E18 at/cm2 in a thickness of 1,4 µm for the Si matrix with Helium release starting at 625 K by heating in vacuum [4]. This behavior allowed to propose these films, initially developed for optical applications, as "helium solid targets"for nuclear reaction studies relevant in astrophysics and nuclear structure. These targets avoid the use of cryogenic or high-pressure cells, making them easier to use, reducing energy straggling effects and simplifying the geometry for calculations. Results will be presented from earlier experiments carried out at LNL [3] to recent experiments at TRIUMF-EMMA facilities [5-6].

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strong text

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FLOGEN NEW SUSTAINABILITY FRAMEWORK AND THE SOCIETAL IMPACT OF FUNDAMENTAL SCIENCE

Author: Florian Kongoli[1]

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The FLOGEN sustainability framework, developed by the author in 2015, clarified the confusion that existed in the definition of sustainability by making a clear distinction between criteria, actors and objectives of sustainable development. Since its development, due to its unified, universal and all-inclusive nature, it has been applied in many fields of science and technology and has been presented as an opening plenary lecture at the United Nations Meeting in Geneva and turned into law by various municipalities, which made it the first time ever that a scientific concept is turned into law.
During this conference, this unique framework of sustainability will first be presented as well as its 3 pillars which are: (1) science & technology (2) governance & management, and (3) education &

civil society. Secondly, it will also analyze the many applications of this framework on fundamental science and its impact on society development and how fundamental scientific knowledge can be used to achieve sustainable development for the benefit of humanity. Finally, the progress and difficulties that arise as well as opportunities in this field in the context of this unique framework, as well as the essential and irreplaceable role of science and technology.

EURASC Symposium (session 2) / 8

Solvay Institutes: Over a Century of Scientific Excellence & a Bright Future

Author: Yves Geerts[1]

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The Solvay Institutes are unique not only in their history and prestige, but also in their ability to identify emerging scientific themes and to bring together the best researchers from diverse backgrounds around them. Their exceptional added value therefore stems from the founding nature of their scientific activities and their resolutely forward-looking orientation. The Institutes are therefore actors in scientific research, unlike the Nobel Foundation, which essentially rewards major past discoveries. As newly appointed Director of the Solvay Institute for Chemistry, I would like to present the current activities and my vision for a collaborative and interdisciplinary approach of Science.

EURASC Symposium (Session 4) / 20

Impact of physical properties of nanomaterials in the next generation diagnostic devices

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The rapid advancement of nanotechnology has opened new frontiers in the design of diagnostic devices with unprecedented sensitivity, selectivity, and speed. Central to this progress are the unique physical properties of nanomaterials—including size-dependent optical, electrical, mechanical, and surface characteristics—which enable innovative mechanisms of signal generation and transduction. Metallic nanoparticles with localized surface plasmon resonance, semiconductor nanocrystals with quantum confinement effects, and 2D materials with high carrier mobility have all been exploited to push detection limits down to the single-molecule level. In addition, tunable surface area, porosity, and flexibility allow the seamless integration of nanomaterials into miniaturized and wearable devices, paving the way for personalized and point-of-care diagnostics.
This presentation will demonstrate how tailoring the physical properties of nanomaterials can be strategically leveraged to develop next-generation diagnostic platforms, with emphasis on optical, electrochemical, and hybrid biosensing strategies. Particular attention will be given to their roles as labels in biosensing formats and as modifiers in label-free transduction platforms for detecting cancer biomarkers, neurodegenerative diseases, and pathogens—including viruses.
Finally, future perspectives will be discussed, including challenges of reproducibility, large-scale manufacturing, and regulatory approval, as well as opportunities for integration with artificial intelligence and digital health technologies. Importantly, the intrinsic compatibility of nanomaterials with sustainable architectures—such as nitrocellulose membranes, biodegradable plastics, and low-cost, scalable fabrication methods like inkjet printing, screen-printing, and stamping—will be highlighted as a pathway toward affordable, eco-friendly, and widely deployable diagnostics.

EURASC Symposium (Session 3) / 21

How physics fundamentally limits promises of Artificial Intelligences

Author: Eric Suraud[None]

Calculations, and more recently computations, have been intimately linked to physics since centuries. The 2024 Nobel prize in physics provides the latest illustration thereof. Modern physics really emerged when the use of mathematics was generalized to support the physical description of the universe. Computations nowadays have become a key tool of investigation in physics, both for modeling and for data analysis. Conversely, modern computers capabilities have been attained thanks to major physics-based developments, like the invention of the transistor. These relations between physics and computations are somewhat obvious and well documented.
The emergence of Artificial Intelligence (AI) both in science and all-day life might change the rules of the game. Fundamentally AI systems remain computer-based objects with all the above-mentioned links to physics. But AI now promises computations hardly conceivable only a few years ago. This might lead people to think that limits of AI will always be overcome, again and again. This would mean, on the long term, a strictly rational and deterministic viewpoint on the world and a latent hope to solve any "unsolvable"problem. Such a potential viewpoint may hold true in many sciences, not speaking of situations in all-day life issues.
However, it turns out that computations and AI suffer from intrinsic limitations, first due to technical issues in the representation of numbers they manipulate. These difficulties are well known, as well as strategies to overcome/control them, at least partially. More fundamentally, computational possibilities hit walls imposed by the laws of physics. The physical description of the world leads to address complex non-linear equations which allow chaotic behaviors. These chaotic features cannot be overcome, whatever accuracy is attained numerically, so that the practical description of the world is bound to integrate a chaotic component. Furthermore, quantum mechanics introduces a random component into the description of microscopic systems. This may have macroscopic consequences as for example a radioactive disintegration of a nucleus or the hit of a smartphone by a cosmic ray leading to an unexpected error in the system. All in all, to imagine a fully controlled, strictly rational and deterministic, access to the world by computational means is thus confronted with major physical impossibilities.
The aim of this contribution is to demonstrate and illustrate this fundamental impossibility. This is a key issue in our way we see and hope to understand the world. The premise of the analysis does not rely on vague arguments or on faith but on well-established, scientific, facts. It is thus important to keep in mind such limits whatever computations and AI might allow, both today and in the future. The point is not to dispute possible progress attained by AI, although caution should remain the rule, especially in terms of ethical and social issues. This latter aspect will of course also be discussed. But the major point is to identify the fundamental limits set by physics.
This concerns all of us. While physicists will in principle be aware of most of the aspects addressed here, it is clear that many scientists, users of AI in particular, are probably not. It is thus important that the scientific community, as a whole, becomes aware of these limits set by nature to AI and computations in general. More generally speaking, all educated people should integrate this aspect into their understanding of the world, as this very understanding is more and more mediated by AI' s and computations. The societal impact of such a realization is thus crucial.

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From CERN to Industry: Digital Twin Applications Powered by AI

Author: Gang Mu[1]

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The integration of Digital Twin technology with AI Engine is transforming how research and industry understand, predict, and optimize complex systems. Building upon collaborative initiatives between CERN, InnoSuisse, and industrial partners, this talk explores how open-science can be extended into scalable, data-intelligent frameworks for real-world applications.

At the core lies the AI-enabled computational architecture that connects simulation, experimentation, and decision intelligence. By coupling CERN's high-fidelity modeling environment with industrial process data, this framework enables predictive control, dynamic optimization, and explainable risk management across domains such as supply chain, healthcare and finance.

The presentation will illustrate case studies where AI-powered digital twins accelerate innovation, improve operational resilience, and bridge the gap between scientific modeling and industrial deployment. It will also outline the vision for an applied mathematics alliance, fostering reproducible, transparent, and AI-augmented collaboration between academia and industry.

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Ensuring Trustworthy and Sustainable Measurements in the AI Era: Quantifying Uncertainty and Environmental Impact

Authors: Annarita Tedesco[1]; Egidio De Benedetto[2]; Immacolata Esposito[2]; Leopoldo Angrisani[2]; Luigi Duraccio[2]; Sabatina Criscuolo[3]

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Artificial intelligence (AI) is revolutionising measurement systems in electrical and electronic engineering, enabling advanced data analysis, real-time decision-making, and automation of complex measurement tasks. However, the deployment of AI-based models in measurement contexts introduces critical challenges, particularly regarding the reliability and traceability of their outputs and the sustainability of the measurement processes themselves.
This work addresses these challenges by developing rigorous methodologies to quantify the uncertainty associated with AI models used in measurement tasks. Traditional measurement systems rely on well-established physical models with defined uncertainty budgets and metrological traceability. In contrast, AI models are often treated as black boxes, lacking explicit evaluation of their measurement uncertainty, thereby limiting their acceptance in safety-critical or regulated contexts. Our research proposes the integration of metrological uncertainty quantification methods with AI model validation, enhancing the credibility and interpretability of AI-based measurements. The developed approach combines sensitivity analysis, probabilistic modelling, and performance metrics to provide comprehensive uncertainty budgets for AI-assisted measurements, thus enabling their integration into industrial, healthcare, and scientific applications that demand high confidence levels.
Furthermore, this work explores the evaluation and improvement of the environmental sustainability of measurement processes. Measurement activities, while typically considered low-impact, involve instrumentation, power consumption, maintenance, and data processing infrastructure that contribute to environmental footprints, particularly in large-scale or continuous monitoring applications. We introduce a systematic framework to assess the energy consumption and environmental impact of measurement systems, identify key contributors to unsustainable practices, and propose mitigation strategies, such as optimising measurement protocols, enhancing equipment efficiency, and adopting eco-design principles in instrumentation development.
By combining uncertainty quantification and sustainability assessment, this research contributes to building trustworthy, resource-efficient, and socially responsible measurement systems, thereby enabling safer and more sustainable adoption of AI technologies in critical sectors and aligning with global goals for industrial innovation and environmental protection.

EURASC Symposium (Session 3) / 29

How life experiences influence health across generations: An epigenetic perspective

Author: Isabelle Mansuy[None]

Behavior and physiology in mammals are strongly influenced by life experiences and environmental factors, particularly those encountered in childhood. While positive factors can favor proper development and mental and physical health, adversity and traumatic events increase the risk for psychiatric, cardiometabolic and autoimmune diseases and cancer in adulthood. These complex disorders can affect directly exposed individuals and their descendants, in some cases across generations. The biological mechanisms underlying the inheritance of environmentally-induced (acquired) traits are unlikely to involve changes in the DNA sequence but rather depend on epigenetic processes. To study these mechanisms, we developed a mouse model of traumatic stress in early postnatal life that causes symptoms across generations1–3. The symptoms include increased risk-taking, depressive-like behaviors, cognitive and social deficits, as well as metabolic and cardiovascular dysfunctions that persist across life in exposed animals. Further, some symptoms are manifested by the offspring of exposed individuals e.g. risk-taking behaviors up to the 5th generation in the patriline 4. In humans, childhood trauma also affects mental and physical health, suggesting conserved effects across species5, 6. At a molecular level, exposure is associated with epigenetic changes involving RNA and DNA methylation in somatic cells across the body and in germ cells, with sperm RNA being causally linked to the transmission of symptoms from father to offspring3. MiRNAs are also affected in extracellular vesicles in blood and the reproductive tract7. Circulating factors were identified as mediators of alterations in germ cells. Chronic injection of serum from trauma-exposed mouse males into control males recapitulates metabolic phenotypes in the offspring, suggesting information transfer from serum to germ cells. Pathways involving peroxisome proliferator-activated receptor (PPAR) are causally involved, with pharmacological PPAR activation in vivo affecting sperm transcriptome and metabolic functions in the offspring and grand-offspring6. Together, these findings suggest the existence of an ensemble of factors and mechanisms that can carry information about past experiences from the periphery to germ cells and mediate the inheritance of acquired traits8–11.

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EURASC Symposium (Session 4) / 30

Wetland's biogeochemistry: a framework driving from basic research to climate change mitigation

Author: Antonio Camacho[1]

[1] *University of Valencia*

Our planet is nowadays experiencing an unprecedented situation of accelerated climate change linked to the exacerbated anthropogenic emissions of greenhouse gases (GHG). Additional to the natural biogeochemical exchanges between the biosphere and the atmosphere, the huge increase of GHG fluxes deriving from fuel burning has produced a sharp increase of CO2 concentrations in the atmosphere, but also of other GHG such as CH4 and N2O, which are very much related to biogenic activities. Undoubtfully, anthropogenic GHG emissions need to be drastically reduced to net zero emissions, but further to fuel burning emissions, the focus needs also to be set on the way ecosystems work biogeochemically, as this can strongly influence its role in climate change mitigation or, instead, in its enhancement.

Due to the presence of water, wetlands are among the most biogeochemically active ecosystem types on Earth, enabling them to manage with huge amounts of GHG. Several natural factors, such as the hydrology, water salinity, inorganic and organic nutrients availability, among others, regulate the carbon and GHG exchange between these ecosystems and the atmosphere. Basic research on the carbon cycle has provided the foundational knowledge to interpret not only how these natural factors are determining the role of different types of wetlands in increasing or reducing the GHG concentrations in the atmosphere, but also how and which way the alteration of these characteristics by anthropogenic impacts causes changes in its climate regulatory capacity. As a general pattern, ecologically degraded wetlands may enhance climate change mainly because of the alteration-related increase in the emissions of the GHG with higher radiative forcing capacity, CH4 and N2O. Instead, healthy wetlands can help in climate change mitigation when minimising the emissions levels of both GHG.

Here we jump from basic research to societal contributions of science. Since healthy wetlands may act as climate allies, the use of appropriate management measures and ecosystem's restoration aiding to enhance their climate change mitigation role needs to be based on sound scientific foundations. But we, as scientists, also need to adapt our research questions in order to target humankind needs to preserve our common home, The Earth. Furthermore, policies, such as those dealing with biodiversity conservation, climate, and any other type of policy (for example, the EU Nature Restoration, the EU climate policy, and the EU Common Agriculture Policy), must be linked in such a way that, apart of their own specific targets, they can jointly contribute to human efforts to face climate change. In this talk I show a workflow to scale-up from the basic biogeochemical research to effective climate change mitigation by wetland ecosystems while also enhancing other ecosystem services, in benefit of humankind wellness and a healthy planet.

EURASC Symposium (session 2) / 31

Conservation planning for climate change amid deep uncertainties

Author: Camille PARMESAN[1]

Co-authors: Alexis Rutschmann [2]; Dan Warren [3]; Linda Mearns [4]; Matthew Moskwik [5]; Melissa Bukovsky [4]; Robert Lempert [6]; Set McGinnis [4]

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Recent climatic changes have already impacted biodiversity, but estimates of the percent of species threatened with extinction by 2100 range from 1% to 80%. This uncertainty stems partly from differences among algorithms used to estimate species' current and future projected ranges, and from differences among modeled projections of future climate. There is little agreement as to which species' distribution model or which climate model is "best", leaving conservation planners often lost in a sea of possible futures from which to choose a management pathway. Here, we used a Robust Decision Making (RDM) approach to look across a wide range of possible futures and identify robust conservation strategies for 20 different species of concern. We estimate the distribution of potential habitat for each species (both now and in the furture) using multiple Species Distribution Models (SDMs), with multiple sets of modeling parameters and GCM-RCM combinations, resulting in ˜400-700 potential futures per species. We then analyse five different conservation strategies for their reliability and potential for regrets. We ultimately seek the most robust decision pathways, given known uncertainties. We found that (i) Climate change considerably affects the future distribution of all the species; (ii) There is considerable variation in the spatial distribution of each species amongst possible futures; (iii) Current state of understanding is not sufficient to estimate which of these futures is most likely; (iv) RDM approaches are helpful in navigating these uncertainties to identify robust management pathways for species conservation. The study offers a innovative conceptual framework that could be adapted to specific circumstances to produce actionable biodiversity conservation plans that are robust to highly uncertain climate futures.

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Plurality of Worlds, Plurality of Inhabited Worlds?

Author: Michel Mayor[1]

[1] *Geneva University*

Since ancient times, human curiosity has led us to wonder about our place in the cosmos. Greek philosophers were convinced that an infinite number of "worlds"existed in the universe. And they already evoked the possibility that some of these "worlds"could harbor living species. In today's terms: do planets exist around other stars? Is life present elsewhere than on our Earth? Modern technology has enabled the discovery of thousands of exoplanets, some with conditions compatible with the complex chemistry required for the possible development of life. But: Does life exist elsewhere in the universe? Do we have the means to detect it? Will modern science answer these questions?

EURASC Symposium (session 1) / 34

Impact on Society of Fundamental Science

Author: Tejinder Virdee[1]

[1] *Imperial College (GB)*

Progress in fundamental science allows us to get a deeper understanding of how Nature works through great scientific discoveries. Over the centuries this understanding has very much altered the way we live –giving us a better life –providing us with paradigm shifting technologies. From electricity and semiconductor electronics to telecommunications, medical imaging, GPS, and even the World Wide Web—first created at CERN just over 35 years ago—each leap in understanding has sparked technologies that revolutionized society.

In this talk, we'll explore a few of these paradigm-shifting technologies to show how fundamental science continues to power progress and improve our world.

EURASC Symposium (session 1) / 36

About the Impact of European Academies of Engineering in European social, economic and technological development

Author: Sebastiao Feyo de Azevedo[1]

[1] *University of Porto*

The presentation will focus on the common features that can be understood in the missions of the European Engineering Academies, which are associated with the mission of Euro-CASE, The European Council of Academies of Applied Sciences, Technologies and Engineering, currently made up of 22 Academies of European countries, of which the Portuguese Academy is a member.
In a broad view, the mission of such Academies is to pursue, encourage and maintain excellence in the fields of engineering, applied sciences and technology, and promote their science, art and practice for the benefit of the citizens of Europe, indeed to promote economic and social development. This can be achieved, and is being achieved, through a number of policies and activities, namely (i) by developing studies on specific cases; (ii) by providing impartial, independent advice on engineering and applied science issues that affect Europe and its people to the European Commission and Parliament, very specifically through close cooperation with the European organization SAPEA – Science Advice for Policy by European Academies; or (iii) by ensuring that the societal impact of technological change is given proper attention with full consideration of environmental and sustainability aspects.
To flesh out this broad view, just a few current activities can be mentioned: (i) the very recent work (completed) in cooperation with SAPEA, on "Successful and Timely Uptake of Artificial Intelligence in Science in the EU"; (ii) studies concerning critical raw materials; (iii) studies on critically toxic per- and polyfluoroalkyl substances (PFAS); (iv) promoting a platform to foster engineering and technological innovation ecosystems with the overall goal of reinforcing technological innovativeness and the competitiveness of Europe.

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Welcome from EURASC Symposium chairman

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Welcome from EURASC President

EURASC Symposium (Session 3) / 40

The Strategic Nexus: Harnessing the Convergence Research and Innovation for Europe's Societal Resilience

Author: Maria Cristina Russo[1]

[1] *EU DG Research*

TBD

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Welcom from CERN DG and talk: CERN's mission and impact on society

Author: Fabiola Gianotti[1]

[1] *CERN*

TBD

EURASC Symposium (session 2) / 43

Academia Europaea –contributions to societal impacts of fundamental sciences

Author: Donald Dingwell[1]

[1] *University of Munich*

As the Academia Europaea approaches the 40th year of its existence the world's perception of fundamental sciences and their contributions to societal impacts have evolved remarkably since its creation.
In addition to the fundamental role of its members in the creation and exchange of knowledge the Academia Europaea has, increasingly, been recognised as a fundamental resource for knowledge-based advice for policy in Europe.
This trend has accelerated recently whereby the Academia Europaea, in addition to its traditional roles in several Europe-wide Academy consortia and working groups, is now a central facilitator for Europe in the Science Advice for Policy by European Academies (SAPEA) process and the G20 (S20) process.
These activities will be reviewed and discussed.

EURASC Symposium (Session 4) / 44

The societal impact of fundamental research and technology sovereignty –two antipodes? The case of advanced materials in Europe

Author: Jürgen Tiedje[1]

[1] *EU DG Research*

In the last fifteen years, several Nobel Prizes in physics and chemistry have been awarded to material science discoveries –discoveries combined with the expectation to have an impact on our global economy and societies: graphene, gallium nitride, lithium-ion batteries, quantum dots, and metal-organic frameworks.
Since the last five years, global competition between economies on critical technologies is high on the agenda. Research and innovation in these technologies are exposed to a scrutiny against the

risk of having choke points. Governments want to ensure ‘technology sovereignty”for the benefit of their economies and societies. Materials –access to critical raw materials as a resource and access to advanced materials as a technology –are an intrinsic part of this discussion.
The European Union considers advanced materials as a priority where societal impact of materials science and technology sovereignty should not –in a figurative sense - turn into antipodes: on one side, a discussion amongst and for scientists and, on the other side, a focus only on technology sovereignty. In February 2022, a few important scientists, researchers and innovators set out their vision in a "Materials 2030 Manifesto"on how to avoid the two antipodes: accelerating research for the benefit of European societies, tackling strategic dependencies and using innovative markets as a launchpad for more growth and jobs.
The subsequent discussions have triggered a European strategy in February 2024 which the European Commission has been rolling out together with Member States. They will also clearly inform the future Advanced Materials Act which the Commission announced under its "Competitiveness Compass"in early 2025 and which it intends presenting later next year. Competitiveness of European industries which matter for advanced materials has become a defining challenge for all.

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Test

Author: Paul LECOQ[None]

TBD