

2024 EU-U.S. NanoEHS Communities of Research Workshop Summary

The National Nanotechnology Coordination Office (NNCO), on behalf of the National Nanotechnology Initiative (NNI), the International Network For Researching, Advancing, and Assessing Materials for Environmental Sustainability ([INFRAMES](#)), and the Swiss Federal Institute of Aquatic Science and Technology ([Eawag](#)) co-hosted the 12th EU-U.S. NanoEHS Communities of Research (CORs) workshop on 16 October 2024. The hybrid-format meeting took place at the Eawag campus in Dübendorf, Switzerland. The 2024 meeting was co-located with, and immediately preceded the INFRAMES meeting on October 17 and 18. Fifty participants from government, academia, and industry in the United States, Europe, and South America attended the workshop in person. A total of 110 persons from Africa, Central and South America, Oceania, South Asia, and Southeast Asia joined virtually over the course of the meeting.

The 2024 meeting sought to reinforce connections between EU and U.S. nanotechnology environmental, health, and safety (nanoEHS) communities and their relevance in the evolving nanotechnology landscape. The workshop program drew on U.S. and European Commission (EC) speakers to further conversations between the NNI and the EC on bridging the U.S. legislative directive supporting nanotechnology and the current EU priority supporting advanced materials R&D, which builds upon and overlaps with previous activities in nanotechnology. Speakers reiterated that advanced materials and nanomaterials are of strategic importance, as are their networked communities, regardless of the framework. In the coming year, the U.S.-EU nanoEHS CORs will continue to focus on building closer connections between U.S. and EC institutions while exploring connections with nanosafety networks in other regions. The CORs will be active in promoting the value of the tools and platforms developed by decades of nanoEHS research for emerging nanotechnology and advanced materials applications.

Additionally, to maximize the value to both the CORs and INFRAMES community, the CORs 2024 workshop programming was complementary to the INFRAMES theme of *Scaling Up to Complex Systems*, with speakers exploring this concept in plant and *in vivo* to *in vitro* systems. The CORs community continues to highlight the environmental and human health impacts of incidental nanomaterials, with the meeting also including a case study of nanoscale particles produced by tire and brake wear. The community identified working with stakeholders and industry to reduce exposure to incidental nanoparticles released through tire and brake wear. Developing more sustainable materials (e.g., “green” tires) would exemplify responsible research and innovation.

More detailed descriptions of the sessions can be found below.

Carsten Schubert, senior scientist at Eawag welcomed workshop attendees on behalf of the Institute’s Directorate and provided a brief overview of several of Eawag’s current projects. Jürgen Tiedje, the Head of Unit in the European Commission’s (EC’s) Research and Innovation Directorate General also welcomed the group, stressing the importance of EU-U.S. cooperation in managing the potential risks of advanced materials and nanotechnology. Tiedje emphasized the importance of creating opportunities for free market research and asked the community to consider how nanotechnology fits into the EU’s recent prioritization of advanced materials (AMs) research and regulation in carrying out a safe(r) and sustainable by design (SSbD) agenda.

NNCO Director Branden Bough reiterated Tiedje's call for continued collaboration. He stressed the United States' commitment to nanotechnology by highlighting the 21st Century Nanotechnology Research and Development Act which codified the NNI into law. The U.S. government's investment in nanotechnology annually exceeds U.S. \$2 billion, with a cumulative U.S. \$45 billion since the inception of the NNI over 20 years ago. The NNCO director pointed to the significant impact that nanotechnology investments have played in the development and U.S. leadership in a diversity of fields and also updated the attendees on the NNI's national nanotechnology challenge, [Nano4EARTH](#). Nano4EARTH has brought the nanotechnology community together to accelerate the technical development of solutions to environmental challenges. To this end, Nano4EARTH has many elements that are recognizable in an SSbD context and within the scope of the United Nations' Sustainable Development Goals.

Monique Groenwold, Senior Coordinator at the Dutch National Institute for Public Health and the Environment (RIVM), delivered the keynote address, "NanoSafety Cluster Roadmap: Safe and Sustainable Advanced and Innovative Materials 2024-2030." Groenwold's presentation introduced the NanoSafety Cluster (NSC) and described key elements of the EU's near-term focus: realizing the EU [Advanced Materials for Industrial Leadership](#) policy and promoting research and industry action to address societal challenges, within a robust safety and sustainability framework. Groenwold reminded the nanoEHS CORs community that the European Commission's interest in novel materials extends beyond nanomaterials, pointing out challenges with this transition, such as a lack of definition of AMs.

In SSbD, sustainability and safety innovation require the early and frequent involvement of experts in the research and design of new materials. The nanotechnology community is well placed to contribute tools, methods, and approaches to guide this transition and facilitate the creation of a circular economy that minimizes harm while still providing consumers with affordable and trustworthy products. The "early and often" approach can lead to regulatory preparedness, wherein emerging technology challenges are anticipated – rather than chased – after the fact. Groenwold noted the importance of applying FAIR (Findable, Accessible, Interoperable, and Reuseable) principles of data collection, storage, and sharing to building effective collaboration across these challenges. By making data understandable, reusable, and replicable, researchers can avoid redundancies and contribute to artificial intelligence (AI) tools.

Following the keynote talk, Characterization COR co-chairs Vladimir Lobaskin (University College Dublin) and Anil Patri (FDA) moderated a panel discussion on "Nanomaterials within an Advanced Materials Framework: Definitions, Regulation, and Sustainability." Hubert Rauscher (EC Joint Research Centre, the JRC) reminded the group that discussions about the relationship between nanomaterials and AMs have a common framework and that innovations should address safety, sustainability, and functionality together from the earliest stages. Rauscher also pointed out the difficulty in defining nanomaterials and the JRC's review of [international regulatory definitions of nanomaterials](#). Rauscher concluded that most nanomaterials are, themselves, AMs, and closed with comments on the importance of safe and sustainable development, regardless of categorization.

Janet Carter (OSHA) shared early definitions from ISO (International Organization for Standardization) and the NNI, followed by an overview of the use of definitions for nanomaterials by U.S. agencies. While definitions across agencies are broadly similar, each agency has tailored their definition to be fit-for-purpose for the regulatory and research missions. In closing, Carter noted that the U.S. federal interagency groups have taken this into account in their cooperation on data sharing, research projects, and policy information. The final presenter on the panel, Agnes Oomen (University of Amsterdam and the Dutch

National Institute for Public Health and the Environment), spoke about the Organisation for Economic Co-operation and Development's (OECD) Working Party on Manufactured Nanomaterials (WPMN) and the WPMN's Steering Group on Advanced Materials (AdMa). Oomen, a co-chair of AdMa, laid out the OECD's approach to nanomaterials and AMs and introduced the Safe(r) and Sustainable Innovation Approach (SSIA), which combines SSbD and regulatory preparedness principles. The AdMa co-chair made the case that AMs are important for solving key global challenges but cautioned that regulating them remains crucial despite the challenges presented by their novelty. Further conversation revolved around how collaboration can continue between the United States and the European Union, considering the European Commission's shift in focus to AMs.

Risk Management COR co-chairs Keld Alstrup Jensen (The National Research Centre for the Working Environment) and Khara Grieger (North Carolina State University) introduced the session on "Responsible Research and Innovation within the Global Nanotechnology Community." Noting the shift in governance from risk to innovation, the co-chairs' highlighted the importance to responsible research innovation (RRI) of both top-down and bottom-up approaches to risk assessment that leads to SSbD in a circular economy. Steffen Foss Hansen's presentation provided the European perspective on RRI in nanomaterials. Foss Hansen, a faculty member of the Danish Technical University, identified four dimensions: anticipation, reflexivity, inclusion, and responsiveness in this process. Foss Hansen expressed concern at the pace of movement toward AMs despite the challenges that remain with nanotechnology and the decrease in attention to and funding of RRI.

Research to address the environmental and human health impacts of plastic and polymer pollution remain interest area for the CORs. The interactive exercise for the 2024 CORs workshop focused on a class of incidental nanoscale particles – tire wear particles. The session was organized by Ecotoxicity COR co-chair Olga Tsyusko-Unrine (University of Kentucky), and Exposure COR co-chairs Christof Asbach (German Institute of Energy and Environmental Technology) and Paul Westerhoff (Arizona State University). The co-chairs began the session with topical overviews. Asbach compared the trends in automobile exhaust to tire and brake wear emissions. Westerhoff discussed the challenges of measuring wear, particularly from brakes, and Tsyusko the impact of tire and brake wear particles on ecological systems. The CORs asked Melanie Auffan (European Centre for Research and Teaching in Environmental Geosciences) to address scaling up ecological research. Auffan discussed the positive value in using mesocosms to measure the risk posed by ecological contaminants.

Session co-chairs asked attendees to form small groups to suggest EHS research activities on tire and/or brake particles that could be scaled up to mesocosm studies. Participants were asked to hypothesize about projects that could be accomplished with roughly U.S. \$ 1million. The co-chairs debriefed the group on the solutions proposed during the interactive exercise. These included working with industry and other stakeholders to create sustainable solutions, for example, developing "green" tires. The CORs co-chairs will use this feedback to develop possible 2025 COR activities. Recommendations for going forward include combining the key themes from the introductory talks (mesocosm study application, characterization and measurement of emissions, and ecological impacts) into a collaborative research proposal and/or as themes for the Exposure COR bi-monthly talks.

The final session of the workshop was organized by the Databases and Computational modeling COR and was titled: "Scaling up in Complex Systems." Tobias Stöger (Helmholtz Munich) spoke on "Translating Dosing Regimes When Scaling up Systems." Stöger argued that, despite appearing counter-intuitive,

learning from animal models (*in vivo*) to design high-throughput screening tests (HTS), *in vitro* could be considered as scaling up toxicology studies. COR co-chairs Fred Klaessig (Pennsylvania Bio Nano Systems) and Thomas Exner (Seven Past Nine) led an interactive conversation about “Metadata and Informatics Needs and Challenges.” Klaessig and Exner concluded that federated databases (i.e., fully interoperable) may be improbable, but federated (linked) management should still be a goal. Developing a nano-specific persistent International Chemical Identifier (INChI) could address many issues in nanoinformatics. The INChI system of persistent chemical identifiers was developed for the International Union of Pure and Applied Chemistry (IUPAC) and managed by the INChI Trust.

Extending the concept of scaling up in complex systems to ecosystems, Greg Lowry (Carnegie Mellon University) gave a presentation on “Plant Nanobiology: Mesoscale Studies and the Future.” The talk focused on plants as complex systems and thus provide opportunities and challenges to better understand how nanoparticles act in complex systems. He highlighted some ongoing research including targeted delivery, climate-induced plant stress reduction, and the use of artificial intelligence (AI).

In closing the 2024 workshop, Quinn Spadola (NNCO Deputy Director) outlined potential outputs: webinars; special sessions at scientific and technical meetings; and manuscripts for peer-review, white papers, and proposals for collaborative research activities. In this latter area, participants suggested boosting the implementation of data-collection standards and templates; maintaining a directory of researchers; maintaining an inventory of methods; and creating and monitoring joint roadmaps. The COR co-chairs will meet to outline plans for next year based on the workshop feedback.

The agenda and slides from the COR’s meeting can be found on the [2024 workshop website](#).