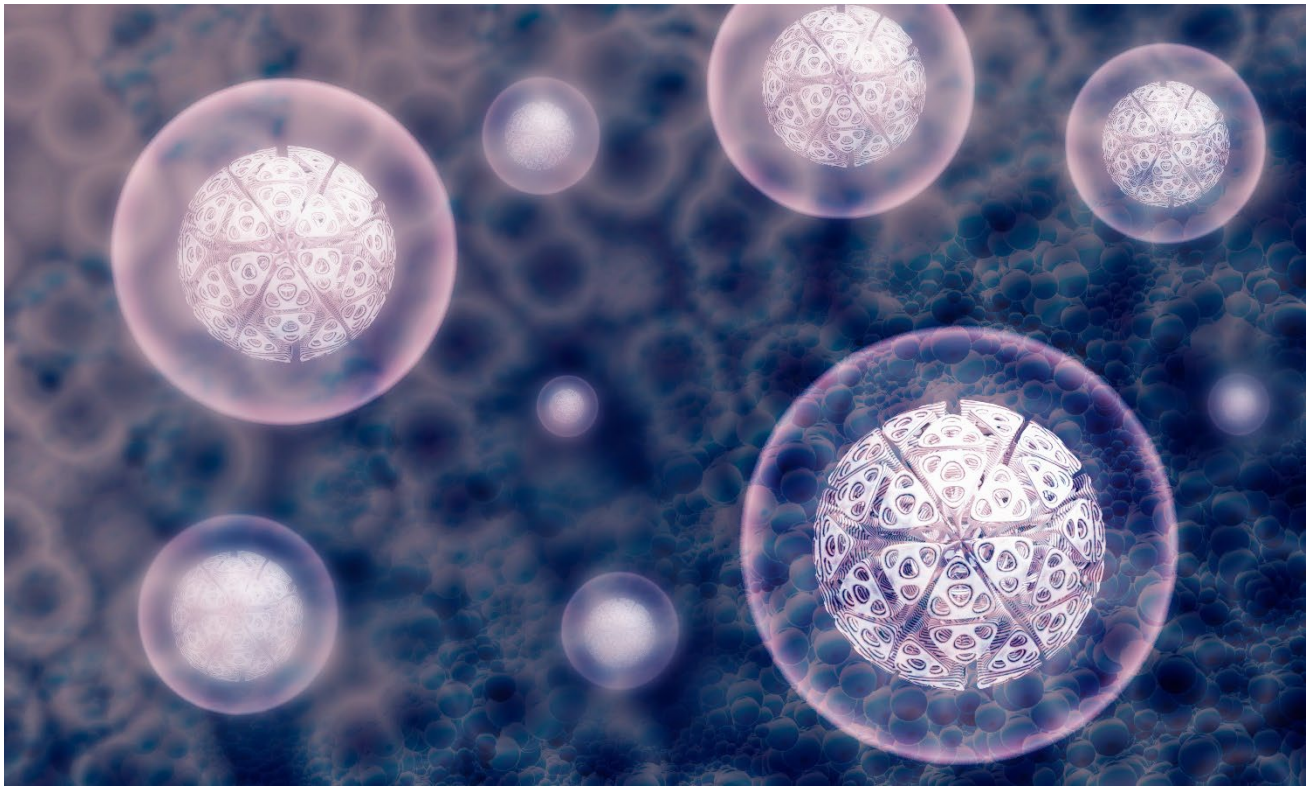
Rapport 2022:3

SweNanoSafe

Swedish National Platform for Nanosafety



Particle mixtures and advanced materials: from production and generation to environmental risk assessment

Notes from SweNanoSafe's 5th Annual Research Network Workshop, 25th November 2022

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Preface

Through a mandate from the Swedish Ministry of the Environment and the Swedish Chemicals Agency (KEMI), SweNanoSafe maintains a national platform for the safe handling of nanomaterials, to contribute to the achievement of the environmental quality goal of a non-toxic environment and protecting human health. The platform aims to disseminate knowledge and provide specific support to authorities on issues related to the safe handling and use of nanomaterials. SweNanoSafe brings together academia, authorities, industry and organisations for a joint dialogue on nanosafety. This also includes identifying needs for the safe handling of nanomaterials and contributing with proposals for solutions and concrete measures that meet the needs, as well as actively promoting improved nanosafety.

Since 2019, SweNanoSafe has been run at the Institute of Environmental Medicine, Karolinska Institutet (KI), by a Steering Board linked to an Operations Coordination Group, an Expert Panel, a Council of Government Agencies, a Research Network and an Education Network. SweNanoSafe organises workshops and meetings, collaboration nodes and communication via a website (www.swenanosafe.se).

On November 25th 2022, SweNanoSafe and the Swedish University of Agricultural Sciences (SLU) organised the 5th Annual Research Network Workshop. The online workshop was chaired by Geert Cornelis and attracted some 40 participants. Here, an overview of the workshop contents and the key outcomes are summarised, including speakers' biographies.

SweNanoSafe thanks the invited keynote speakers, the session moderators, and all participants for their valuable contribution to the discussions and results of the workshop.

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National Platform for Nanosafety

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Content

The Research Network's Annual workshops

SweNanoSafe's Expert Panel has established a network for Swedish nanosafety researchers which was inaugurated in June 2018. Since then, the Expert Panel annually arranges an annual workshop on a topical theme, offering scientific talks and a forum for networking. The network was created on the initiative of SweNanoSafe to support interdisciplinary collaboration, to highlight and to increase the visibility of nanosafety research in Sweden, to identify research needs and priorities for future research, to provide quality-approved information for all stakeholders and act as a pool of national experts for international bodies such as the OECD. Information about the network and how to join is given on the SweNanoSafe weblage (https://swenanosafe.ki.se/research-network/).

This 5th annual research network workshop attracted some 40 participants. The participants were mainly from academia, followed by industry, government and research institutes (Figure 1).

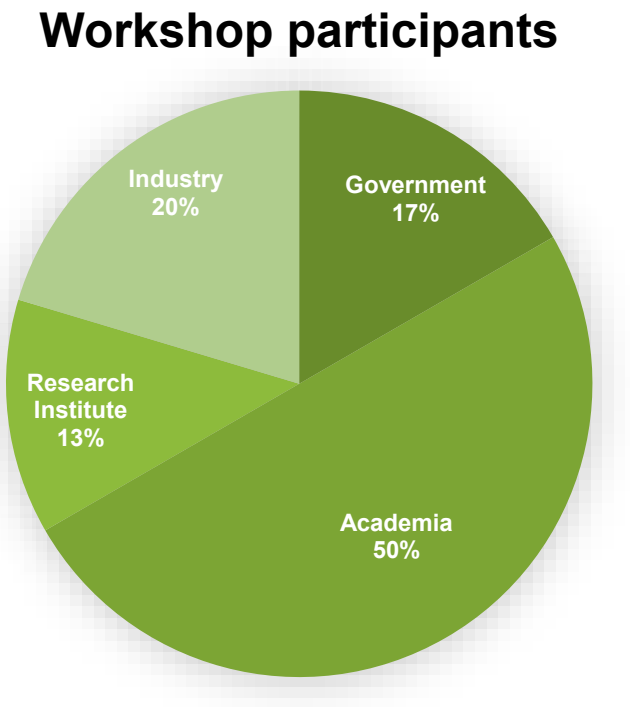

Figure 1 Overview of participants at the workshop.

Introduction: Are we ready for mixtures of nanoparticles?

Bengt Fadeel, Karolinska Institutet and chair of the SweNanoSafe Steering Board, opened the workshop by welcoming everyone and presenting the background, aims and activities of SweNanoSafe. Geert Cornelis then introduced the topics for the day, which originate from necessary transition from single material risk assessment to assessment of mixture of nanoparticles and advanced materials. Hence, the theme for this year's workshop was "Particle mixtures and advanced materials: from production and generation to environmental risk assessment". More specifically, keynote speakers were invited to offer longer talks giving an overview on four different topics and associated key questions:

1. Production and generation: what sort of products can we expect in the future? What are "advanced materials"?

2. Measurement: Is it currently all possible to detect these materials, particularly in an environmental monitoring context? What are the knowledge gaps?

3. Exposure: What sort of changes do we need to environmental exposure models to predict their fate accurately? What are the knowledge gaps?

4. Environmental hazard: What needs to be done differently relatively to "conventional" nanomaterials in terms of hazard assessments?

Invited speakers

Dr. Mikael Syväjärvi is the founder of Alminica, a company aimed to build innovation capacity in advanced materials research and innovation and ICM Research Institute, whose focus areas are energy and environmental advanced materials, nanotechnology materials, innovation capacity and sustainability. He has a research background in developing advanced materials such as semiconductor materials for energy and environment. Furthermore, he has extensive experience in advanced materials innovation and international technology transfer.

Dr Andreas Gondikas is a group leader at the University of Athens, but is currently also affiliated to the Institute for Marine Sciences at Gothenburg University. His research concerns the development of analytical tools for measuring nanomaterials in complex environmental matrices as well as the fate of nanomaterials, both in freshwater and marine systems. He thus has been involved in several European projects focusing on developing measurement techniques for nanomaterials in the environment based on techniques such as single-particle ICP-MS.

Dr. Antonia Praetorius is an assistant professor at the University of Amsterdam. Dr. Praetorius' research interests centre around assessing and modelling the environmental fate of emerging chemical contaminants, such as engineered nanomaterials, nano- and microplastics and microfibers. In her research she combines modelling approaches with laboratory-based studies on contaminant fate processes. She is also involved in work towards improving analytical methods for identifying emerging contaminants in different environmental matrices.

Dr. Elma Lahive is an ecotoxicologist affiliated with the centre of ecology and hydrology in Wallingford, UK. Her research targets the fate and effects of chemical pollutants in the environment, with a particular focus on understanding the underlying mechanisms of toxicity, linking the biological fate of pollutants with their toxic effects in organisms. She has investigated the ecotoxicology of nanomaterials and microplastics in several European projects and has contributed to improving risk assessments of these materials.

Meeting Agenda

Presentation slides are available online at SweNanoSafe.se.

10.00 Welcome and introduction – Geert Cornelis, SLU, Bengt Fadeel, KI

Session I Chair Hanna Karlsson

10.10 – 10.50 **Theme I: Production and generation**

Speaker: Mikael Syväjärvi (Inst. Advanced Materials, Intl. Association of Advanced Materials, Alminica AB, SE)

10.50 – 11.30 **Theme II: Measurement**

Speaker: Andreas Gondikas (National and Kapodistrian University of Athens, GR)

11.30 – 12.10 **Theme III: Exposure**

Speaker: Antonia Praetorius (University of Amsterdam, NL)

12.10 – 13.00 lunch

Session II Chair Alexander Lyubartsev

13.00 – 13.40 **Theme IV: Hazard assessment of complex nanomaterials and particle mixtures**

Speaker: Elma Lahive (Centre for Ecology & Hydrology, UK)

13.40 – 14.30 Breakout session I

14.30 – 14.45 short break

14.45 – 15.30 Breakout session II

Session III Chairs Helen Karlsson and Harri Alenius

15.30 Conclusions-Group discussions

16.00 End of workshop

Group discussions

During the afternoon, group discussions were held during two breakout sessions. The aim of the breakout sessions was to pinpoint knowledge gaps in the different aspects of risk assessments of particle mixtures and advanced materials. For each session, the participants were invited to join the discussion room of their choice, among three topics in which the keynote speakers acted as discussion facilitators:

- **Measurement,** facilitated by Dr Andreas Gondikas
- **Exposure,** facilitated by Dr Antonia Praetorius
- **Environmental hazard,** facilitated by Dr Elma Lahive

In addition to the topical discussion facilitation Dr Mikael Syväjärvi rotated between rooms to offer insights connected production and generation of advanced materials.

Concluding discussion

In the discussion, several difficulties in current research and projections of future challenges.

From the breakout session on ***measurements*** the two main points concerned analytical challenges and information sharing or transfer. Materials that we expect to be relevant in the future, such as e.g. silicon carbide and graphene, pose analytical challenges and are difficult to measure with currently available techniques. For instance, the resolution of the instruments used today is insufficient for many of the materials and matrices of interest. Most environmental matrices contain naturally occurring carbon that interferes with these measurements so currently, we are forced to apply lengthy sample preparations protocols.

Open data and information sharing was also pointed out as a challenging area. There are obstacles to openly sharing information, both from the researchers' and manufacturers' perspective. Furthermore, not all journals are open to publishing negative results, creating a bias in the scientific knowledge exchange that scientific publishing constitutes. However, it was also noted the situation with the bias against negative results is improving.

From the breakout session on ***exposure*** several knowledge gaps were highlighted connecting to understanding and modelling the environmental fate of advanced materials. A major challenge is to ascertain what organisms truly are exposed to, in the environment as well as our testing systems. The environmental conditions, or test conditions influence the formation of aggregates etc. There is also the question of transformation and its reversibility in different uses and life cycles, will the materials ever shift back into the

pristine forms? Advanced materials consist of multiple compounds, which poses challenges to understanding both processes affecting fate and toxicity. For instance, in the case of alloys, the toxicity of the individual metals will in most instances not be the same as that of the alloy.

From the breakout session on **effects**, the discussions connected to issues of definition of advanced materials and communication. To date, there is no clear and broadly agreed upon definition of advanced materials. There is not even an agreement of whether the focus of such a definition should be on material or on the advanced function. It can furthermore be questioned if the term advanced materials is relevant in the context of hazard assessment. Advanced is a relative term and what is considered advanced today will not be advanced in the future. Nevertheless, advanced materials do pose challenges to hazard assessment. We do not know for sure whether testing and evaluation protocols for nanomaterials and regular materials work for advanced materials. Clarifying mechanisms of action and use of Adverse Outcome Pathways and New Assessment Methodologies for will likely be useful ways forward for hazard identification and assessment in the future. Here more research is needed to integrate these concepts into a hazard assessment framework. Developing new approached to hazard assessment and the use of non-standard data will require communication with regulators, researchers and regulators need to understand each others' viewpoints in order to make progress in this area.