NanoFASE
NEWSLETTER #1 WINTER 2016
Nanomaterial Fate and Speciation in the Environment

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Our work
Our people
We were here

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Our goal

To deliver an integrated Exposure Assessment Framework (protocols, models, parameter values, guidance...) that:

- ✓ Allows all stakeholders to assess the environmental fate of nanomaterials released from industrial nano-enabled products
- ✓ Is acceptable in regulatory registrations
- ✓ Can be integrated into the EUSES model for exposure assessment under REACH
- ✓ Allows industry a cost-effective product-to-market process
- ✓ Delivers the understanding at all levels to support dialogue with the public and consumers.

Our ambition for ENM Fate and Exposure Assessment is to match or surpass the level achieved for conventional chemicals.

Editorial

by Coordinator Claus SVENDSEN

NanoFASE: Facing up to the challenges of Nanomaterial Exposure Assessment

NanoFASE aims to deliver an integrated environmental **Exposure Assessment Framework** applicable to engineered nanomaterials (ENMs) to enable understanding and prediction on the "exposure" side of the risk assessment equation (Risk = Exposure x Hazard). We are building novel concepts, approaches and models to underpin scientifically-driven tools of varying complexity and maximal usability. NanoFASE outputs will support both the development of academic understanding, and actual decision-making by regulators, industry and SMEs.

Some of the innovative aspects of our 4-year endeavour are to: consider the environmental compartments through which ENMs pass as "reactors" in which the particles are sequentially transformed; employ dynamic multi-media fate modelling; and develop functional fate groups to distinguish the transformed variants of the original ENMs after passage through a reactor. NanoFASE uses real industrial and bespoke aged ENM test sets representing these variants, to develop method, parameter and model catalogues that will overcome current risk assessment roadblocks.

Ultimately the NanoFASE tools will all be instantly accessible through an online "Clickable Framework" linking measurement protocols, models and derived parameters. NanoFASE will progress beyond current mass based analysis of production and flows, to a fine-grained spatial and temporal quantification and modelling of ENM forms releases to different waste streams and environmental reactors, in all stages of ENM-enabled product manufacture, use, disposal, and recycling (including accidental releases).

This first Newsletter issue surveys the progress of our first year with 42 partners (including 4 Swiss and 7 Non-European) and introduces our Young NanoScientists. You can learn too where to meet us in joint training and dissemination events, like the sp-ICP-MS event in January 2017 at RIKILT (The Netherlands) or our open workshop with ACEnano in September 2017 in Birmingham (UK) linked to the ICEENN 2017 and the US-EU Bridging Communities of Research (CoR) meetings.

Please visit our project website: www.nanofase.eu where you will find NanoFASE Scientific Talks on video, further insight into work packages, and deliverable reports and scientific publications as they come out. News and events are announced through our Twitter account @NanoFASE_EU.

I hope that you will subscribe to and enjoy the future issues of the NanoFASE newsletter.

CLAUS SVENDSEN (CEH – NERC)

Meet us here

GET READY FOR SEPT 2017 - NANOFASE WILL HOLD ITS FIRST OPEN STAKEHOLDER WORKSHOP.

Industry, Regulators and Academics are welcome. Come see the 1st version of the NanoFASE Exposure Assessment Framework and how the tools generated (models, SOPs etc) work, and join open discussions collecting feedback and suggestions for improvements. Get insight into scientific progress in each NanoFASE workstream, and come into the lab for hands-on workshops – make your own nanoparticles and test the tools for evidence provision for both US and EU regulatory registration of nanoproducts. The event will be co-organized with the ACEnano project and aligned with the ICEENN 2017 conference in Birmingham UK, where the 2017 US-EU CoRs bridging event also will be held.

Follow @NanoFASE_EU and be the first to register!

MAY 2017 - NANOFASE IS LOOKING TO DEVELOP A HANDS-ON WORKSHOP "TRACING AND MODELLING FATE OF NANOMATERIALS IN THE ENVIRONMENT"

We're hoping to organize a short course presenting recently developed tools (assays, models) for tracing, modelling and predicting the fate of nanomaterials released from nano enabled products as they pass through various waste streams into and through different environments and biota.
Focus will be on how these data will feed into the exposure models of SimpleBox4Nano and EUSIS. Stay informed: @NanoFASE_EU.

JAN 10 - 12 2017

Fully Subscribed! We will welcome 50 persons from 15 projects to the

spICP-MS training workshop: Theoretical and hands-on training on spICP-MS

Wageningen (NL)

Anna Undas, Wageningen University:
anna.undas@wur.nl

FEB 7- 8 2017

Final conference of the COST Action ES1205 - Engineered nanomaterials from wastewater treatment & stormwater to rivers

Aveiro (Pt)

Susana Loureiro, University of Aveiro,
sloureiro@ua.pt
http://www.es1205.eu/final-conference/

MAR 12 - 17 2017

NanoImpact Conference, a meeting to integrate the scientific knowledge available about nanomaterial exposure, fate, effects and risks in the environment"

Ascona (CH)

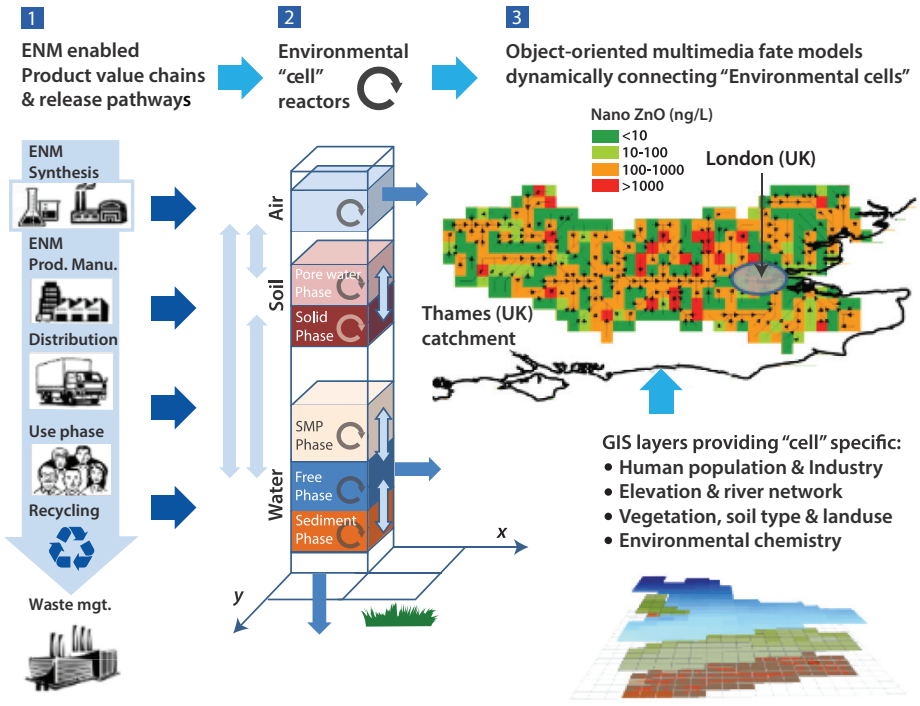
https://www.empa.ch/web/s506/nanoimpact

Our work

NanoFASE aims to produce a new state-of-the-art framework for evaluating environmental release, fate and exposure for ENMs. This work will deliver a streamlined approach to regulation that supports sustainable innovation in nanotechnology.

Our vision is to move from the current approaches of spatial averaging of total production volumes mainly through mass-based lifecycle, release and flow analysis, towards systems that can account for spatial and temporal variability of ENM release and includes effects of transformations on fate. Our future integrated framework, supported by standard operating procedures (SOPs), parameter values, models and guidance, will capably evaluate and incorporate:

1. Behaviour of the actual relevant ENM forms released from ENM products (a distribution of composite bound and free particles);
2. How reactions in waste management and environmental compartments transform such release-relevant ENMs (integrating environmental with ENM properties); and
3. The consequences of these transformations for transport and fate within and between the different environmental compartments including organism uptake.



Our NanoFASE conceptual workflow for delivering dynamic multimedia fate prediction in both a generalised model environment and a GIS enabled mode.

Responding to our regulatory and industrial stakeholders, we plan to implement this figure as an online NanoFASE "Clickable Framework". The user will be able to click through successive layers to reach:
a) detailed models developed for specific release and fate processes
b) experimental and analytical methods used to derive the parameters required to use these models
c) protocols for such investigations.

A final ambition is to try and make this "Clickable Framework" interactive, to receive feedback from user experiences.

NanoFASE is structured around 9 research work packages (WPs) supported by a Dissemination and Interactions package and by a Scientific Coordination package. At the end of our first year our Work Package Leaders report on what has been achieved and where we are going.

WP1 Alison Crossley U.OXFD-DJ

NERC UoB LEITAT IUTA UNIVIE UOXF HEMPEL PROMETHEAN PARTICLES LTD TUL FCCCO AXME ITEX AppNano EMPA INERIS TNO RIVM MIL UNI-Lj UNIVE GBP

EXPOSURE ASSESSMENT FRAMEWORK DEVELOPMENT AND ROAD–TESTING

Tools that industry can use to drive growth

In our first year we have undertaken regular consultations with Industry and Regulators regarding desired outputs of the Exposure Assessment Framework (EAF). We have gathered information on the entire life cycle of various nano-enabled products from our industrial partners and evaluated potential ENM release to the different environmental compartments. These case studies cover current and near market applications such as antifouling coatings, conducting inks for microelectronics / solar devices, antibacterial textiles and environmental remediation treatments.

In the next few months we will be reviewing the portfolio of case studies including data gathered from literature and other EU projects, identifying gaps and updating as appropriate to ensure that we cover all possible release routes, waste management strategies and environmental compartment reactors.

"WP1 will ensure that at term, NanoFASE delivers a fit-for-purpose Exposure Assessment Framework in a form that allows industry to assess the full breadth of nano-enabled product types and uses, in an efficient manner and in accordance with regulatory requirements."

WP2 Steve Lofts NERC

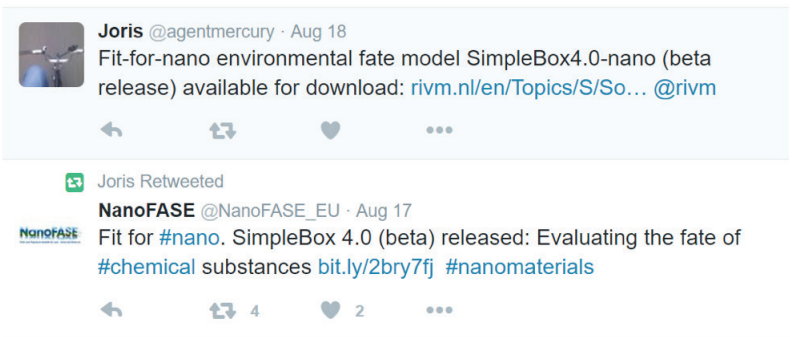
NERC UoB LEITAT IUTA UNIVIE WU EMPA INERIS ETSS TNO RIVM UNIGE VU-Vumc UAVR SLU

MODEL DEVELOPMENT, INTEGRATION AND INTEROPERABILITY FOR MULTIMEDIA FATE AND BIO UPTAKE ASSESSMENT

Developing our fate models – the core outputs of NanoFASE

"WP2 develops core outputs of NanoFASE: spatially-explicit modelling frameworks for predicting nanomaterial fate and bio uptake in the environment."

In our first year we have focused on the specification for the NanoFASE model: our spatially explicit framework for the fate and biouptake of nanomaterials in soils and waters. We have worked with WP1 and the technical workpackages on interfacing the NanoFASE model with particle release and atmospheric model to provide a complete assessment framework from particle manufacture and use to final environmental fate.



Our next task is to get the transport component of the NanoFASE model coded, tested, and fully functioning. We will also continue liaising with the technical workpackages on the development of nanomaterial transformation algorithms for incorporation into the NanoFASE model and SimpleBox4Nano (developed by RIVM in NanoNextNL).

www.rivm.nl/simplebox

nanonextnl
innovating with micro and nanotechnology

WP3 *Iseult Lynch* UOB

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UNIVERSITY OF BIRMINGHAM

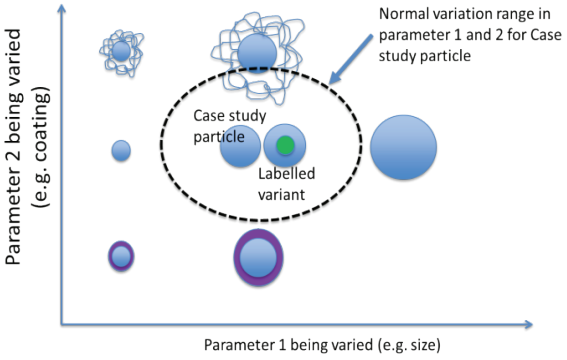
ENM SUPPLY, TRANSFORMATION AND METROLOGY FOR EXPERIMENTAL STUDIES

Making sure that what we want is what we get

Acquisition of case study ENMs and industry-partner supplied ENMs was undertaken as planned. After identifying large batch-to-batch variability or samples not meeting the desired specifications for model validation, WP3 partners got to work early to produce bespoke high-quality particles. Some technical challenges are still to be overcome (e.g. creating rare earth doped Ceria/Titanium core-shell particles). Extensive characterisation is performed to ensure ENMs delivered to partners match the requested specifications as closely as possible.

The next priorities are: i) provision of highly doped ENMs to allow tracking of fate and speciation at low environmental concentrations against a background of naturally occurring particles, and ii) development of methods for direct production of equivalents for the "reactor"-aged ENMs in a scalable manner, such that the environmentally relevant nano-form (the relevant Functional Fate Group) can be tested in each of the "reactors" of WPs 5-9., i.e. in the various environmental compartments (water, sediment, sludge, soil etc.).

"WP3 provides systematically varied sets of high quality ENMs (developed to complement the case study ENMs from WP1) which are used to parameterise the models from WPs 5-9. It also provides characterisation and speciation data under relevant exposure conditions, to identify where ENMs are no longer 'nano' and thus drop out of the models."



NanoFASE concept of developing high-quality systematically varied ENMs around each case study ENM – to enable parameterisation of the models with reproducible ENMs, for subsequent validation with the more variable Case study ENMs.

WP4 *Socorro Vázquez-Campos* LEITAT

LEITAT IUTA UNIVIE UOXF HEMPEL PROMETHEAN PARTICLES LTD TUL FCCCO AXME ITEX EMPA INERIS ETSS TNO GBP

LEITAT Technological Center member of TECNIO

RELEASE FORMS AND QUANTITIES FROM PRODUCT LIFE CYCLE

Possible release pathways to the environment are being charted and prioritised for downstream work in NanoFASE's Environmental Compartment work packages

"WP4 will progress beyond current analysis of mass flows, to quantify and model in space and time the value chain emissions of different forms of ENMs - crucial underpinning for the exceptional realism of the NanoFASE exposure assessment framework."

With our industrial partners, we built up 5 nano-enabled product life cycle case studies (such as antifouling paints for marine use). These have allowed us to perform pathway analyses detecting the environmental compartments in which most of the released ENMs will end up, as well as the transformation that they could experience. In parallel our modellers are analysing current release models, identifying the work needed to modify these and move towards an integrated framework to include country specificity as well as regionalised release data for different product value chains and compartments.

A database is being developed on Excel sheets and includes country-specific characteristics, ENM production volumes scaled down to each European country, product allocation and release factors specific to each product containing ENMs. Different ENM release categories will be taken into account (e.g. pristine or matrix embedded), which should be relevant and usable for the WPs working on fate modelling.

WP5 Ralf Kaegi EAWAG

NERC UoB EAWAG IUTA UGOT UOXF HEMPEL PROMETHEAN PARTICLES LTD TUL FCCCO AXME ITEX ETSS SLU

ENM TRANSFORMATION IN AND RELEASE FROM MANAGED WASTE STREAMS

The NanoFASE pilot Wastewater Treatment Plant is up and running and producing sludge – which we have dosed with nanoparticles to test "real world" aging

NanoFASE innovation

We consider different release processes (weathering, direct release), waste streams (incinerators, wastewater treatment, landfill) and environmental compartments (air, soil, water/sediment, biota) as "reactors" able to transform ENMs from the highly engineered high energy states achieved during fabrication, to environmentally transformed lower energy forms.

Our work focuses on wastewater treatment plants (WWTPs), solid waste and dedicated sewage sludge incinerators, and landfills. We started lab-scale experiments using pristine and well characterized materials, representing realistic fate-relevant forms at each stage, to obtain a mechanistic understanding of the transformation processes in WWTPs. Next, WP5 will be spiking a pilot WWTP with selected ENMs, monitoring their transfer over several months.

"WP5 establishes transformation and release rates of engineered nanomaterials during their passage through managed waste facilities – which are 'reactors' or crucial conduits for ENMs prior to their release into the environment."

Combining bulk analyses and single-particle based methods, we are observing the extent of transformations and whether particles are discharged as individual nanoparticles or as (homo-/hetero-) agglomerates. Next, we'll incinerate and/or pyrolyze ENM enriched sludge, examining the ashes and biochars for the presence of (transformed) ENMs.

WP6 Astrid John IUTA

IUTA UOXF FCCCO INERIS TNO

EFFECT OF ENM FORM ON ENVIRONMENTAL FATE IN AIR

Lab and field experiments to study and predict atmospheric ENM behaviour

"WP6 field and lab studies investigate ENMs in ambient air, their transformation and their direct atmospheric impact – supporting NanoFASE in delivering the first model describing these relevant processes for nanoparticles."

The starting point of our work was a review paper that summarizes the (still modest) current knowledge on Emissions and Possible Environmental Implication of Engineered Nanomaterials in the Atmosphere. Having these information and especially gaps in mind, WP6 designed the lab and field experiments to study the transformation of airborne ENMs during atmospheric transport, especially in view of their surface properties influencing mobility and possibly toxicity.

The "reactor" for lab experiments was built and is currently placed into operation. The field campaign dealing with emission of ENMs from nano automotive products during road transport has started; measurements and data analyses are ongoing.

WP7 Geert Cornelis SLU

NERC UoB UGOT UNIVIE UOXF TUL FCCCO AXME UNIGE MIL VU-Vumc UAVR PE SLU

Swedish University of Agricultural Sciences

ENM FATE AND TRANSPORT IN TERRESTRIAL SYSTEMS

Practically feasible fate descriptors are being developed that will both affordably and accurately predict bioavailability of ENMs as well as the efficacy and safety of terrestrial nanotechnology

Heterocoagulation and transport prediction were in focus in the first year. Heterocoagulation detection proved possible for a limited set of conditions using Nanoparticle tracking analysis and data analysis software was programmed for techniques coupled to single particle ICP-MS. Practically feasible batch tests to measure fate descriptors builds on ongoing expertise in advisory partner Duke University. The FTIR methodology of CSIRO allows us to quickly expand fate descriptors obtained for a limited set of soils to a huge set of soils with minimal cost.

Batch tests will be validated against column tests of stacked and intact soils. A large soil sampling campaign is also underway for the Thames basin, which will be our main study area for the FTIR methodology.

"WP7 will predict and classify the soil types most vulnerable when exposed to ENMs – including nanomaterials intentionally added to soils. This is invaluable for safety assessment of future nano applications: pesticides, fertilizers...."

WP8 Frank von der Kammer UNIVIE

NERC UoB EAWAG UGOT UNIVIE UOXF RIVM UNIGE UAVR UNIVE U

ENVIRONMENTAL BEHAVIOR OF ENM IN WATERS AND SEDIMENTS

Systematic study of dominant transformation and transport processes will deliver critical input data to the NanoFASE model, and sort ENMs into Fate Groups according to their 'most probable' fate pathways

"WP8 investigates the dynamic behaviour and fate of released ENMs in fresh waters, the estuarine mixing zone, marine systems, and also in sediments, especially sediment pore waters, providing insight into key processes controlling ENM agglomeration and transformation."

In our first year we prepared the experimental setups to study heteroagglomeration, dissolution, and surface transformation reactions (e.g. sulfidation) of ENMs that make their way into surface waters. We developed a multidimensional parameter-testing matrix after identifying the major driving parameters affecting the behaviour of ENMs in water. The matrix consists of three dimensions: pH, natural organic matter (NOM) concentration and electrolyte concentration. The parameters will be varied within ranges representative of water chemistries of European surface and coastal waters.

We are now ready to start systematically measuring the different fate processes of ENMs under a wide range of representative conditions as defined by our multi-dimensional parameter testing matrix and provide first input data towards the NanoFASE model.

NanoFASE innovation

We are developing the Functional Fate Groups (FFG) concept, condensing the richness and variability of existing and future ENMs into behavioural categories that summarise likely environmental behaviour and fate. NanoFASE will tackle today's huge data gaps with the breadth of experimental data required for quantification of surface water behaviour across the anticipated range of Functional Fate Groups.

WP9 Nico van den Brink WUR

INERC UoB WU UOXF UOP UNI-Lj VU-Vumc UAVR RIKILT PE

BIOAVAILABILITY, BIOACCUMULATION AND FOOD CHAIN TRANSPORT

Observing the actual uptake of nanomaterials by organisms under environmentally relevant conditions

"WP9 tracks the forms and quantity of nanomaterials taken up by aquatic and terrestrial organisms, and their potential for bioaccumulation in higher trophic levels."

In the first year we selected relevant aquatic and terrestrial species to be addressed. The possible routes of uptake and excretion of nanomaterials have been described, and experiments are being conducted in which those routes are being quantified. These experiments are conducted under environmentally relevant conditions, and will provide the information needed to feed NanoFASE models describing the uptake of nanomaterials in organisms.

In the coming year more experiments will be conducted to increase the number of species that can be modelled. We will also start so-called mesocosm studies including more species, so that interaction between species can be addressed, increasing environmental realism.

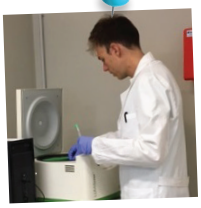
Our People

Young NanoScientists Forum

Véronique Adam
WP4, WP1, WP2

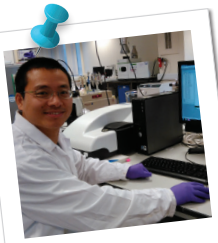
Jessica Adams
WP7

Marta Baccaro
WP9



Andrea Brunelli
WP8

Nathaniel Clark
WP9



Xianjin Cui
WP3, WP5

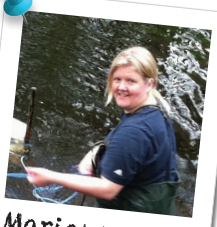
Alexander Gogos
WP5 deputy leader

Alice Horton
WP7

Anita Jemec
WP9

Zahra Khodaparast
WP7, WP9

Elma Lahive
WP7 deputy leader



Marianne Matzke
WP3 deputy leader
WP5, WP7, WP8, WP9

Karin Norrfors
WP7, WP9

Sara Novak
WP9

Vincenç Pomar Portillo
WP1, WP4

Antonia Praetorius
WP8 deputy leader

Patrícia Veríssimo Silva
WP8, WP9

Nathalie Tepe
WP8

We were here

December 2015 – Aloha NanoFASE! At the session on fate and risks in aquatic and terrestrial environments during the Pacifichem conference in Honolulu, Geert Cornelis (SLU, WP 7 leader) presented the approach taken in WP 7 as well as the overall Nanofase project to researchers from North America and Europe.

March 2016 - NanoFASE at the Hands-on Workshop on Nanosafety Assessment organized by the project eNanoMapper with SUN, GuideNano and NanoFASE in Basel. Claus Svendsen (NERC-CEH, NanoFASE coordinator) co-chaired the session on exposure, building on results from the past NanoFATE project.

April 2016 - NanoFASE partners from NERC-Centre for Ecology and Hydrology (CEH) and the University of Vienna presented a modelling framework for the transport, transformation and bio-uptake of manufactured nanoparticles in the aquatic environment at the European Geosciences Union General Assembly 2016.

June 2016 - NanoFASE & applied nanoSafety at Industrial Technologies 2016: a workshop "From nanosafety research to operational tools for the nanotechnology industry" was organized by NanoFASE partner EU-VRi with the NanoSafety Cluster at the largest networking conference in the field of new production technologies, materials, nanotechnology, biotechnology and digitalisation in Europe.

April 2016 - Fate and hazard data from NanoFASE and NanoMILE on the same knowledge platform: A starting point for nucleation of the desperately sought European nanosafety meta-database?

October 2016 - Symposium on Exposure modelling of nanomaterials at ISES2016 Conference - International Society of Exposure Science in Utrecht.

October 2016 NanoEHS workshop - Enabling a sustainable harmonised knowledge infrastructure supporting Nano Environmental and Health Safety Assessment.

November/December 2016 Joint scientific conference of ProSafe & OECD: Science based support for regulation of Manufactured Nanomaterials.

November 2016 NanoSafe Conference.