

NanoSafety/NFFA project NFFA supported internship on NanoSafety

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Context







NFFA asked by the EC to be more active in the field of NanoSafety

A set of actions considered

Internship

Objective: establishing a state-of-the-art & compiling a report with the procedures in terms of NanoSafety put in place by each partner institution







Literature review: fields with regard to NanoSafety



Nanotoxicology: Health, Safety, Environment



Exposure pathways & related hazards (inhalation, skin, ingestion)



Nanomaterials risk assessment & management (exposure & hazard assessments, hierarchy of controls)



Current laws & regulations (REACH, CLP)



Services & organizations working on NanoSafety currently (OECD, JRC-EU, OSHA-EU, NanoSafety Cluster...)

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Future developments (new TGs (OECD), AOPs)

Literature review: fields with regard to NanoSafety



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Nanotoxicology: Health, Safety, Environment

- Health: Routes of exposure:
 - Inhalation: most dangerous route of exposure to nanomaterials



- Little data available on dermal exposure and ingestion
- Safety: present higher fire-explosion risk
- Environment: aquatic eco-system suffering the most



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Literature review: fields with regard to Nanosafety



Current laws & regulations (REACH, CLP)

Chemical Safety

- REACH Regulation (EC) 1907/2006
- CLP Regulation (EC) 1272/2008
- BPR Regulation (EU)
 528/2012

Workers' Safety

- Framework Directive 89/391/EEC
- Chemical Agents Directive 98/24/EC
- Carcinogens and Mutagens Directive 2004/37/EC

REACH: Registration, Evaluation, Authorization and Restriction of Chemicals CLP: Classification, Labeling and Packaging BPR: Biocidal Products Regulation

Literature review: fields with regard to NanoSafety



Services & organizations working on NanoSafety currently (OECD, JRC-EU, OSHA-EU, NanoSafety Cluster...)



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Figure 1. Institutions and organizations working on the topic of Nanosafety at the European and international levels

NIA: Nanotechnology Industries Associations, JRC-EU: Joint Research Centre of the European Union OECD: Organization for Economic Co-operation and Development, EUON-ECHA: European Union Observatory for Nanomaterials-ECHA: European Chemical Agency, OSHA-EU: European Agency for Safety and Health at Work, WHO: World Health Organization, NSC: Nanosafety Cluster

Literature review: Observations

- Current topic of interest
- A lot of research & data, conclusions yet to be drawn
- Lack of clear laws and regulations targeting nanomaterials

→ REACH annexes modified to address nanoforms, applicable from January 1st 2020

NFFA: Nanoscience Foundries & Fine Analysis



State-of-the-art with regard to Nanosafety within NFFA





Method

Short questionnaire on NanoSafety Practices

Nanomaterials characteristics



Nanomaterials hazard & exposure (activities/processes, OELs, measuring devices)



Risk assessment methods



Engineering controls



Administrative controls



Personal protective equipment (PPE)

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Laws & regulations

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Method

Short questionnaire on NanoSafety Practices •

NANOMATERIALS

NANOMATERIALS CHARACTERISTICS

- 1. What are the characteristics of
- working with? Physical form Chemical nature Dry powder Organics Suspended in liquid Organometallics Physically Inorganic bound/encapsulated carbon

Water soluble Metals Nanowires Alloys Thin films Ceramics (metal oxides) Polymers

Are the nanoma	Are the nanomaterials being us				
	Physico-chemi				
	Radioactive				
	Fiammable				
	Combustible				
	Pulverulent/Easi				

NANOMATERIALS HAZARD & EXPOSU

3. Which activities/processes rela In your experience and with reg processes of the nanomaterials think that there are risks related

Dry processes/ Inhalation exposure

Synthesis/Production (Handling (mixing, weighing, scooping))

Dispersion (Sieving, Spraying, Grinding, Sanding, Drilling, Abrasive Blasting, Thermal release, Mechanical cutting/Sowing) Transport (Transporting containers, Dumping bags of powder, Bagging) Wet processes/ Dermal exposure Coating (Dipping, Rolling) Transporting containers Other

- 4. In your experience, which specific NMs or groups of NMs are most relevant with respect to posing a risk to workers? (type?)
- 5. What is the maximum exposure duration to the nanomaterial (s) (Which OEL (Occupational Exposure Limit) values are, if any, being u specific NMs?
- 6. Are any specific measuring devices being used to measure the am present in the working environment? If yes, which ones?
- 7. In your experience, what is the most probable and dangerous mea workers on site with regard to the specific NMs that you are worki Inhalation
 - Skin exposures
 - o Ocular
 - Ingestion
 - Other

WORKERS and HAZARDS

RISK ASSESSMENT

- 8. Approximately how many people are in direct contact and/or work nanomaterials?
- 9. Which risk assessment methods (hazard and exposure assessment: deployed to assess the risk of the nanomaterials being used in you assessments been made before starting work with the nanomateri during or in future?)

10. How often and in which cases does the risk assessment needs to be

WORKERS' HEALTH

Engineering controls

11. What equipment for the protection of the workers' health do you (SAFETY EQUIPMENT:

Che	mical fume hoods			Bag In/Bag Out filter chan	
	Ventilation type	Bottom up			
		Top down			
		Both			
Loc	Local exhaust ventilation			Ventilated bagging or dur	
Ventilated spray booth				Downdraft table	
Nanomaterial handling enclosures				Wet cutting/machining	
Glove box/isolators				Ventilated tool shroud	
Clean rooms (class)				Blasting cabinet	
Bio	Biological Safety cabinets			Other	

- Workplaces are cleaned:
 - Between each manipulation/experiment
 - Everyday
 - Every other day
 - o Once a week
 - Other
- 18. Environmental safety control:
 - · How is the waste collection/disposal during the entire handling and/or production processes managed?
 - Use of sealed bags to dispose of contaminated materials (wipes...)
 - Use of a separate waste stream to keep nanomaterial-contaminated waste
 - Fume hoods with filters to capture nanoparticles before release into the air
 - Other
 - · Do you have any specific practices regarding the protection of the environment?
 - Which legal protocols/norms do you follow to treat the waste produced? (ISOxxx?)
- 19. What action plans did you think best to put in place in case of an accident, incident or emergency (e.g. Nanomaterial spill)?
 - Are any measures and/or other communication systems for warning or signaling an increased risk to safety and health in place (remedial actions, assistance, escape /rescue missions)?
- 20. Did you ever have serious accidents relating to the nanomaterials? If yes, what was the cause and what measures were taken to limit future occurrences?
 - Cause:
 - Measures taken:
- 21. Is having health surveillance necessary within the context of handling nanomaterials?

Personal Protective Equipment (PPE)

22. Personal Protection Equipment:

Gloves	Lab Coat	Body Protection	Safety glasses/	Respiratory
	/ overalls	Suit	face shield	protection masks:
				Type? Filter?
Nitrile		Type 1		
Latex		Type 2		
Neoprene		Type 3		
Other		Type 4		
		Type 5		
		Type 6		

Contact

First contact through email with all of the partner institutions to request a meeting



Figure 3. Map of the NFFA partner institutions across Europe (retrieved from [1])

• 17/20 partners, for whom the questions were relevant, replied = 85%



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- After meeting, summary report of the discussion sent to each partner

Results: Nanomaterials characteristics



Physical Form

Figure 4. Statistics on the physical form of the nanomaterials worked with in the partner institutions of NFFA

• Majority work with powder or suspended in liquid

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2 par form s ry forbidden

Results: Nanomaterials characteristics



Chemical nature

Figure 5. Statistics on the chemical nature of the nanomaterials worked with in the partner institutions of NFFA

Physico-chemical properties and



- 4 partners: no data on any of the physico-chemical properties & toxicity
- 3 partners: no data on toxicity in particular

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Figure 6. Statistics on the physcio-chemical properties and toxicity of the nanomaterials worked with in the partner institutions of NFFA

Results: Activities



Figure 7. Activities and process carried out in the different partner institutions of NFFA

Adequate equipment as suggested by NTRC (NIOSH Nanotechnology Research Centre) in Controlling Health Hazards When Working with Nanomaterials: Questions to Ask Before You Start

- Dumping/bagging: ventilated bagging or dumping stations
- Sand and abrasive blasting: blasting cabinet and fume hoods
- Spraying: ventilated spray booth
- Cutting: wet cutting/machining

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Results: Risk assessment

OEL values

- 2 partners: only values for certain metal oxides (TiO2, ZnO) & CNTs
- All the other partners: not aware of any OEL values that exist or that are used within their respective institutions

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Nanoparticles measuring methods

- 2 partners use techniques for the measurement of nanoparticles in the air using:
- Spatial method
- Temporal method
- Direct reading instruments

 → chemical speciation
 analysis (XRF) or microscopy
 & determination of the
 nanoparticles' morphology.
- Particles in the air collected then analyzed: sp-ICP-MS coupled to A4F for size determination

Risk assessment

- Majority: control banding
- In most cases, not directed towards the specific use of nanomaterials
- 3 partners have
 considered it necessary
 to make a risk
 assessment for the
 nanomaterials
- Use control banding tools such as Stoffenmanager or ART (Advanced REACH Tool).
- One partner conducts cytotoxicity tests



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Results: Administrative controls

Staff Information and Training

Informal between co-workers

NM specific

General chemical safety

Figure 8. Statistics on the staff information and training

Reason: NMs synthesized on-site \rightarrow SDS do not yet exist

Topics:

- Definition of nanosubstance
- Risks associated
- Use of adequate equipment + personal protection measures
- Training through seminars or lectures

2 partners:

8

• lectures + information sessions in future

SDS on nanomaterials



Figure 9. Safety data sheets on the nanomaterials provided to workers

- NS: quantities worked with not sufficient to be treated as separate waste.
- SDS, ECHA & OECD guidelines used to dispose of the chemical waste.
- Basic action plan of confinement, evacuation and assessment



Environmental safety control

Figure 10. Environmental Safety Control measures in place. SB: Sealed Bags, SWS: Separate Waste Stream, FH: Fume Hoods, NS: Nothing specific to nanomaterials



Results: Personal Protection Equipment

• Gloves, nitrile, latex, neoprene



 2 partners use body protection suits for cleaning & maintenance activities



- 15 partners use filtered masks:
 - 7 partners : FFP3 type for cleaning & maintenance activities and protection against highly toxic substances
 - 8 partners: normal half-masks, when needed



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Results: Conclusions

Hazardous NMs:

- Airborne
- Insoluble or poorly soluble
- Heavy metals (Cd)
- Metals NPs (greater oxidation potential)
- High aspect ratio
- Bio-persistent (fibers, CNTs...)

Hazardous activities:

- Maintenance & activities
- Sowing, cutting, welding
- Spraying, abrasive blasting
- Weighing (often not ventilated)
- Transfer

Hazardous sources of exposure:

- Inhalation
- Skin exposure



Results: Conclusions

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- Members of the NFFA consortium each have their own set of practices depending on the type and form of NMs they work with.
 - Powder form → more stringent methods of protection : containment, confinement
- consensus among the partners that there is a clear lack of general awareness
- Lack of standards and regulations directed towards nanomaterials
- Majority of the research facilities are working with the powder form & metals → most prone to pose risk to workers



 More data and guidelines with regard to the safety of NMs



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Outcome

REPORT



- Literature review on the topic of NanoSafety
 - Synthesis & compilation of the best practices of each partner institution
- Report shared with all partners with final observations
- Giving recommendations useable by the whole of the NFFA consortium
- Bringing awareness & sharing knowledge
- Potential establishment of general guidelines

Conclusion & perspectives

- Literature review on the topic of NanoSafety
- Establishing a questionnaire
- First contact with all the partner institutions to request a meeting to establish a state-of-the-art of the general practices with regard to NanoSafety



- Results derived from discussions with the partner institutions
- Report and potential guidelines useable by the NFFA consortium









Thank you for your attention

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