



LILIAM



Bringing Nanosafety expertise from research to industry via training / tutorials

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Context :

During the last decade, progress in nanosafety has allowed to mitigate and control the risk induced by using nanomaterials. Even if nanoforms hazards are still mostly unknown, means of prevention to be implemented in order to protect workers are well established [1] [2]. Besides, specific risk assessment methods exist [3] [4]. However, industries are not fully aware of this emergent risk and the associated mitigation strategies. The popularisation of nanosafety and especially nanosafety training is thus crucial in several fields.

[1]C. Ostiguy, M. Debia, B. Roberge, et A. Dufresne, « Best Practices Guidance for Nanomaterial Risk Management in the Workplace », p. 113.
[2]W. Fransman, J. Schinkel, T. Meijster, J. Van, E. Tielemans, et H. Goede, « Development and Evaluation of an Exposure Control Efficacy Library (ECEL) », p. 9.
[3]D. Hristozov et al., « Frameworks and tools for risk assessment of manufactured nanomaterials », *Environment International*, vol. 95, p. 36-53, oct. 2016, doi: 10.1016/j.envint.2016.07.016.
[4]A. Sánchez Jiménez, J. Varet, C. Poland, G. J. Fern, S. M. Hankin, et M. van Tongeren, « A comparison of control banding tools for nanomaterials », *Journal of Occupational and Environmental Hygiene*, vol. 13, no 12, p. 936-949, déc. 2016, doi: 10.1080/15459624.2016.1200191.

Specific trainings

	BIORIMA	LILIAM	ENDURCRETE	CEA
Fields	Healthcare companies	Additive Manufacturing	Construction companies	All
Objectives	Raising companies awareness following measurement campaigns	Professional certification for three different audiences	Raising companies awareness	Organise nano-related prevention
Duration	2 hours	1 day → 2 days	1 hour	1 day → 3 days
Modalities	Face to face presentation	Face to face presentation	E-learning	Face to face presentation
Attendees	Employers or EHS engineer	Operators, Product or Process Engineer and Manager	Beginners in EHS issues	Operators or EHS engineers

Method

Sector
From medicine to transport industry through cosmetics

Audience
Workers, EHS managers, researchers ...

400 workstations measured

A decade of nanosafety project

Popularization of nano-risk prevention so that people in the field could simply adapt it to their global risk management system

BIORIMA – Nano medicine

Nano measurement campaign in two companies: **dental and lipidot synthesis** were performed in the frame of BIORIMA project. **Two different communication supports** were developed to take into account **the level of knowledge in nanosafety of the company (beginner for the dental synthesis, advanced for the lipidot synthesis)**. These two presentations were based on the same plan of content:

- 1) **Generic information** regarding nanomaterials & nanorisk
- 2) **Measurement campaign results**
- 3) Occupational health **advices hierarchized** according to the campaign results and observation

The main outputs are:

- 1) **Knowledge transfer on nanosafety basis**
- 2) **Exposure assessment on the fields** (based on both measurement and EHS visit)
- 3) **Customized actions plans** for the companies
- 4) Contributing to the **integrate risk management framework**

LILIAM – Additive manufacturing

The EHS chapter contains information linked to :

- Regulation & Definition
- Hazards and risks associated to AM
- Nanosafety

The EHS management and mitigation sections deals with:

- Risk assessment
- Risk prevention and mitigation

The LCA and LCC includes:

- Definition
- LCA: AM impact on product lifecycle
- LCC: costing models and applications to AM
- Case studies

LILIAM, Lifelong Learning in **Additive Manufacturing** (AM), aimed to tackle the lack of multidisciplinary competences by setting up an **European professional training program** for specialists, engineers and managers in the field of AM technologies. An entire work package was dedicated to **safety and one chapter to nanosafety**. This course is **fully adapted to the audience** (table below) and based on CEA experiences in nanosafety issues related to AM:

Plan of content / audience	Product Engineer	Process Engineer / Operator	Manager
EHS issues		Complete	Summary
Risk management and mitigation		Complete	Summary
Life Cycle Assessment & Cost	Complete	Complete	Complete
Duration	1 day	2 days / 1 day	1.5 days

ENDURCRETE - Construction

In ENDURCRETE project an one hour e-learning is dedicated to EHS issue in construction industry. The course contains the following sections :

- 1) Introduction to EHS
- 2) Occupational risk in construction industry
- 3) Emergent risk related to nanoforms
- 4) Organization and workers involvement

The section dealing with nanoforms last twenty minutes over the complete hour and focusses on:

Exposure assessment

Example : Measurement during sanding operation
→ High submicronics and micronics particles emission some nanoparticles

Real-time measurements: Concentrations of particles emitted during sanding reach: 10⁶ to 10⁷ p/cm³. Submicronics and Micronics particles.

Off-line characterizations: Submicronics and Micronics particles. Some nanoparticles stack on bigger particles. Chemical composition similar to concrete.

Nanoforms in construction industry

Structural function and durability improvement

Applications	Nanomaterials	Properties
Cements, mortars and concretes	Clay Carbon nanotube Amorphous silica	Fire resistance Lightness, mechanical resistance, durability and electrical conductivity Fluidifier, mechanical resistance, thermal protection
Wood coatings	Aluminium Oxides	Scratch resistance
Glass	Amorphous silica	Scratch resistance
Wind turbine pale	Amorphous silica Carbon nanotube	Lightness and fire resistance Mechanical resistance and lightness

- Definition and terminology
- How to address and measure nanoforms. The complexity of nanoforms measurement is defined. Methods, tools and equipment related to these measurements are presented. An example of measurement campaign in construction industry is shown.
- Nanoforms in construction industry
- “Nano-risk prevention” present the different steps of prevention against nano-risk. This section aims to help attendees in their choice.

Conclusions and perspectives:

Making industries aware of the available nanosafety tools, methods and means of prevention is crucial to avoid health and safety issues. Specific trainings should be developed for industry sector, professional workers as well as beginners in occupational health and safety issue. Through different EU projects, the CEA Nanosafety Platform currently develops specific training to bring existing resources to their intended industrial users. This type of initiatives enable companies to increase their nanosafety awareness in a sustainable way.

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