

FROM RESEARCH TO INDUSTRY

cea

nano  
SAFE'16

EXPOSURE ASSESSMENT TO NOAA AT WORKPLACE – AN  
OPPORTUNITY TOWARDS A SAFER AND MORE RESPONSIBLE  
DEVELOPMENT OF NANOCOMPOSITES: NANOLEAP PROJECT



Cécile DUCROS | 8 novembre 2016

Univ. Grenoble Alpes, CEA Tech LITEN, **PNS**, F-38000 Grenoble, France

[www.cea.fr](http://www.cea.fr)

**PNS**  
PLATE-FORME NANO SÉCURITÉ

# Overview

- Introduction → Nanoleap project
- Methodology → Measurement strategy : OECD Harmonized tiered approach
- EXPOSURE ASSESSMENT TO NOAA (**N**ano-**O**bjects and their **A**gregates and **A**gglomerates) → Workplaces studied : configuration and results
- Conclusion

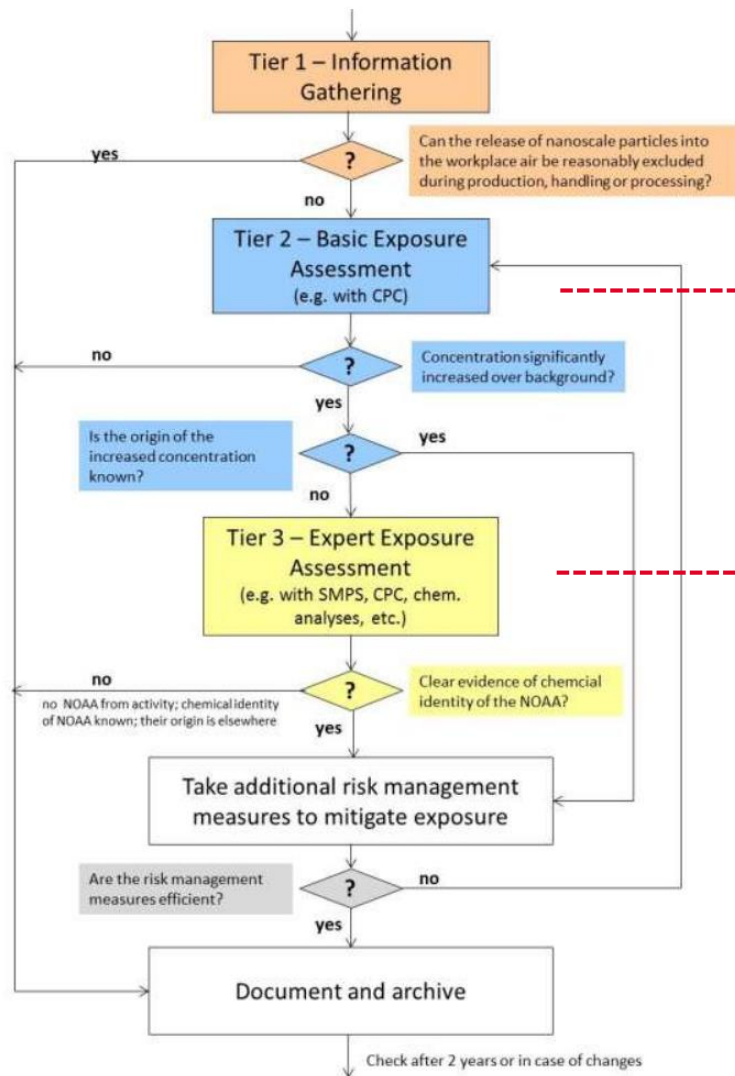
- NANOLEAP project brings together a European Network of pilot production facilities focused on scaling up nanocomposite processing methods to enable the leap from laboratory-scale developments to industrial production.

This Network of pilot plants, properly equipped and skilled to incorporate nanoparticles or nanoadditives in the process, will effectively support the research activities of the industrial stakeholders across the European Construction value chain, specially manufacturing SMEs, which are not able to assume the technological risk and associated investments for developing new technologies .

The goal of this infrastructure is enable the progress of the product to next steps of technology deployment such as installation of industrial lines and enter in the commercialization stage.



# MEASUREMENT STRATEGY: OECD HARMONIZED TIERED APPROACH



*DiSCmini<sup>1</sup>*



*CEA's equipped mobile cart  
(CPCs, NSAM, FMPS, ELPI ...)*

<sup>1</sup> Todea et al., *J. Aerosol Sci.* **89**: 96-109, 2015;  
Todea et al., *Sci. Total Environ.* (close to submission)

## PROCESS: Spray-Drying pilot plan



Background particle concentration around 40,000 #/cm<sup>3</sup>

Four workplaces with potential emissions

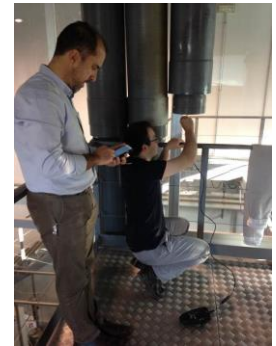
- Main floor: Switch feed tank TF-101,
- Main floor: Recovery of nanoparticles got out of cyclone CY-101,
- Second floor: opening of the cover of equipment DC-101,
- Operation on L-101 bag filter.

## CPE and PPE

Collective Protection Equipment (CPE) are based on static and dynamic containment :

- containment chamber
- extraction a each floor:

PPE worn during handling are:



## Analysis

- Significant amount of ENM manipulated
- Four workplaces with potential emissions are selected for a tier 3 assessment
- Field measurement planned in November

# PILOT PLANT OF NANO-REINFORCE AEROGEL VIA FREEZE-DRYING ( UCLM)

**PROCESS:** Equipment for freeze-drying process



Samples, wet gel  
(solid state)

Background particle  
concentration around  
110,000 #/cm<sup>3</sup>

Several steps :

- ENM are dispersed in water
- the materials are prepared by applying freezing of the wet gel in a freeze dryer
- sample is dried by varying both the reduced pressure and the temperature.

## CPE and PPE

Collective Protection Equipment (CPE) are based on **static and dynamic containment** :

- containment chamber

No cleaning operations are required.

PPE worn during handling are:

- nitrile gloves
- safety glasses
- lab coat

## Analysis

- Small amount of ENM manipulated
- The potential emissions in normal work are probably very low. In normal work, no significant emissions may occur.
- Tier 3 assessment is not necessary

# PILOT PLANT OF NANO IMPRINTING ROLL TO ROLL TO PRODUCE BIOMIMETIC HYDROPHOBIC AND SELF CLEANING NANOCOMPOSITES (IMDEA)

## PROCESS

Equipment for polymer nanocomposite film imprinting



ENM suspension

Background particle concentration around 5,000 #/cm<sup>3</sup>

Several steps :

- dispensing of ENM
- film pass by an optional heating step
- UV step
- rewinding step

## CPE and PPE

Collective Protection Equipment (CPE) are based on **static and dynamic containment** :

- containment chamber
- three extraction :
  - global extraction of the containment chamber
  - local extraction in the oven
  - extraction of ozone

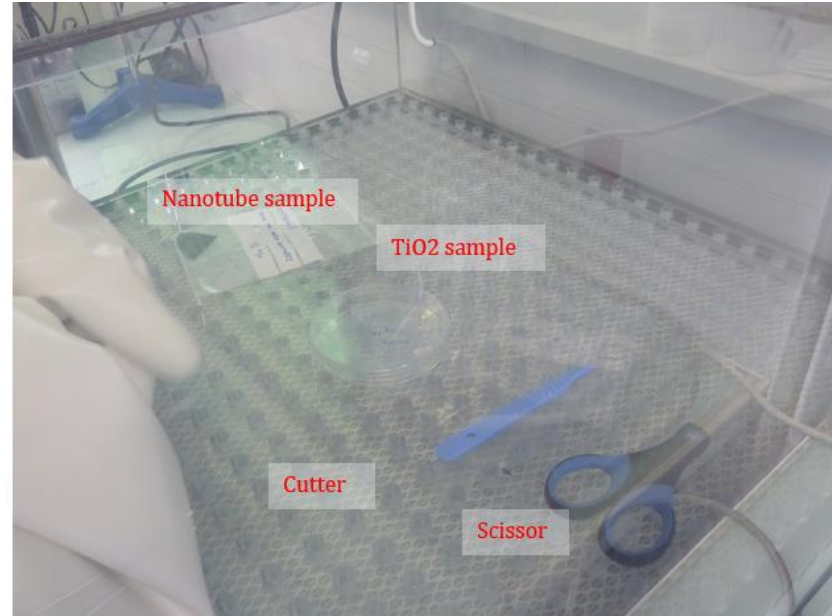
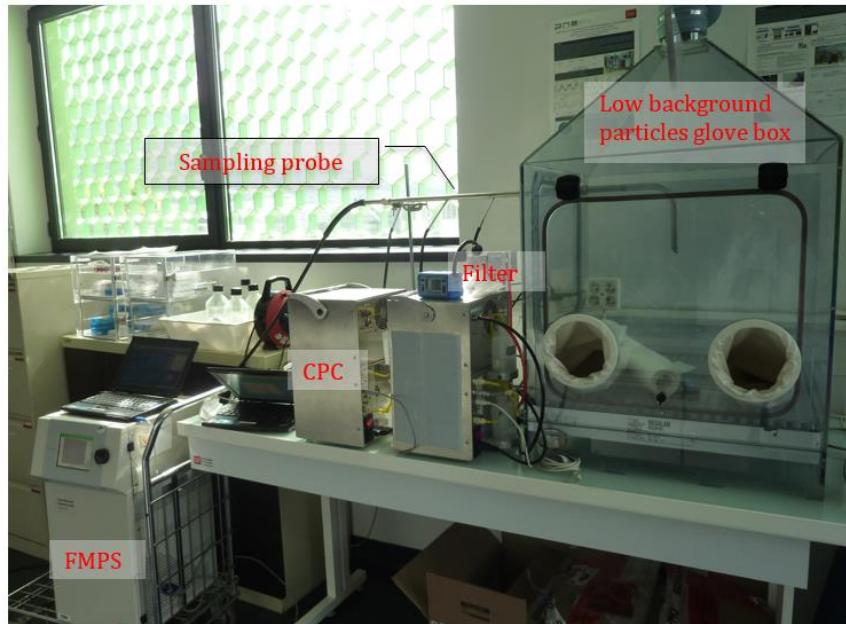
PPE worn during handling are:

- Latex or nitrile gloves
- Laser safety glasses when UV light is turn on

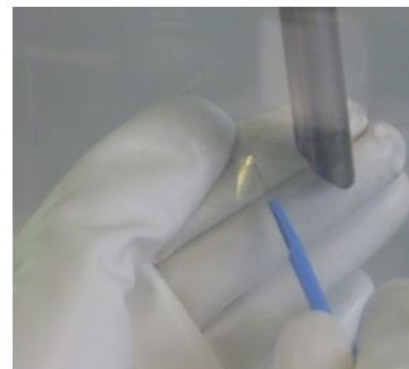
## Analysis

- Small amount of ENM manipulated
- The potential emissions in normal work are probably very low and the probability of an exposure at PBZ is even lower
- No tier 3 but two sample of film were given by IMDEA for test in low background box

## Release test bench



Samples and tools for mechanical stresses



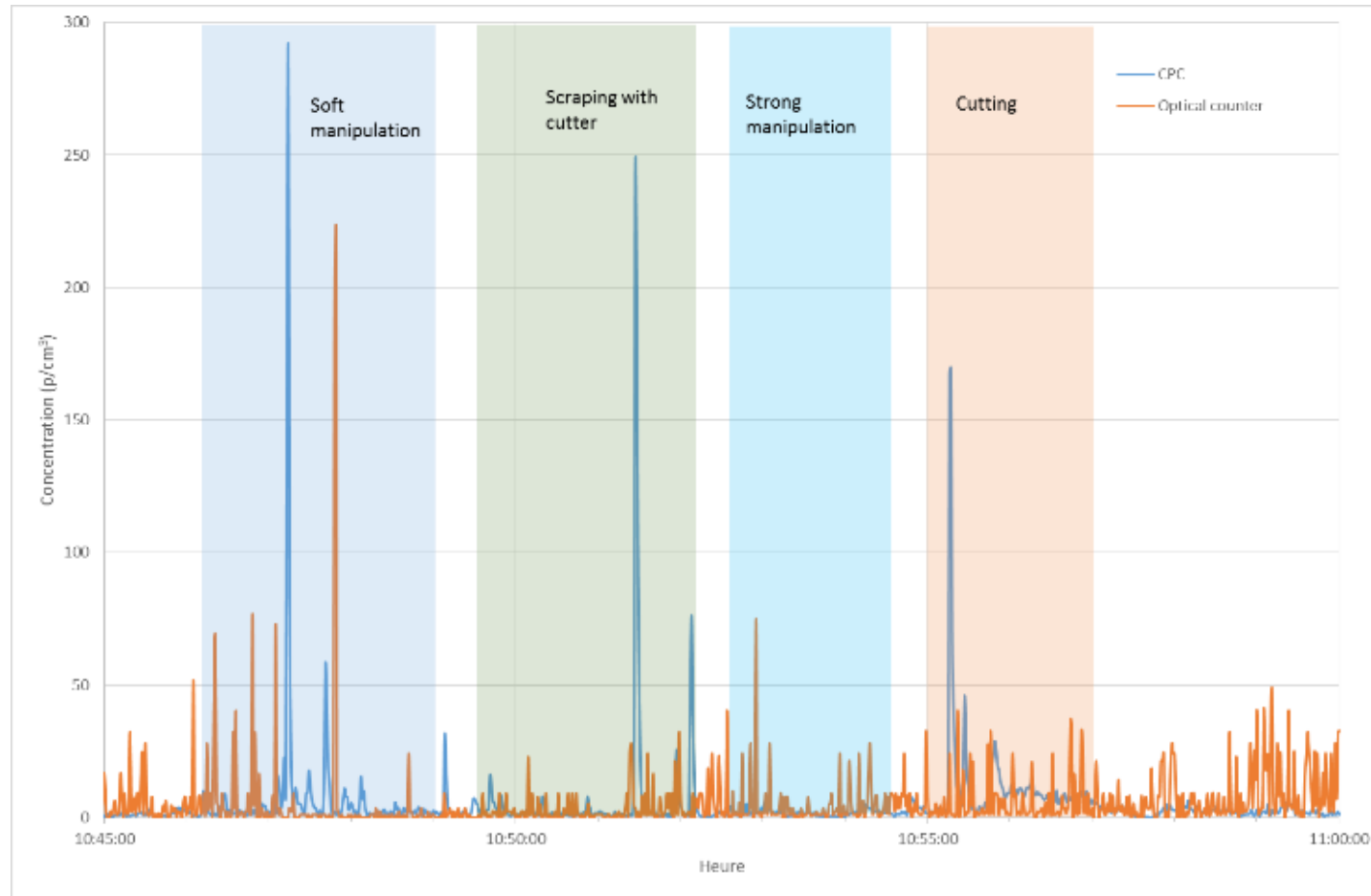
Scraping on TiO2 sample



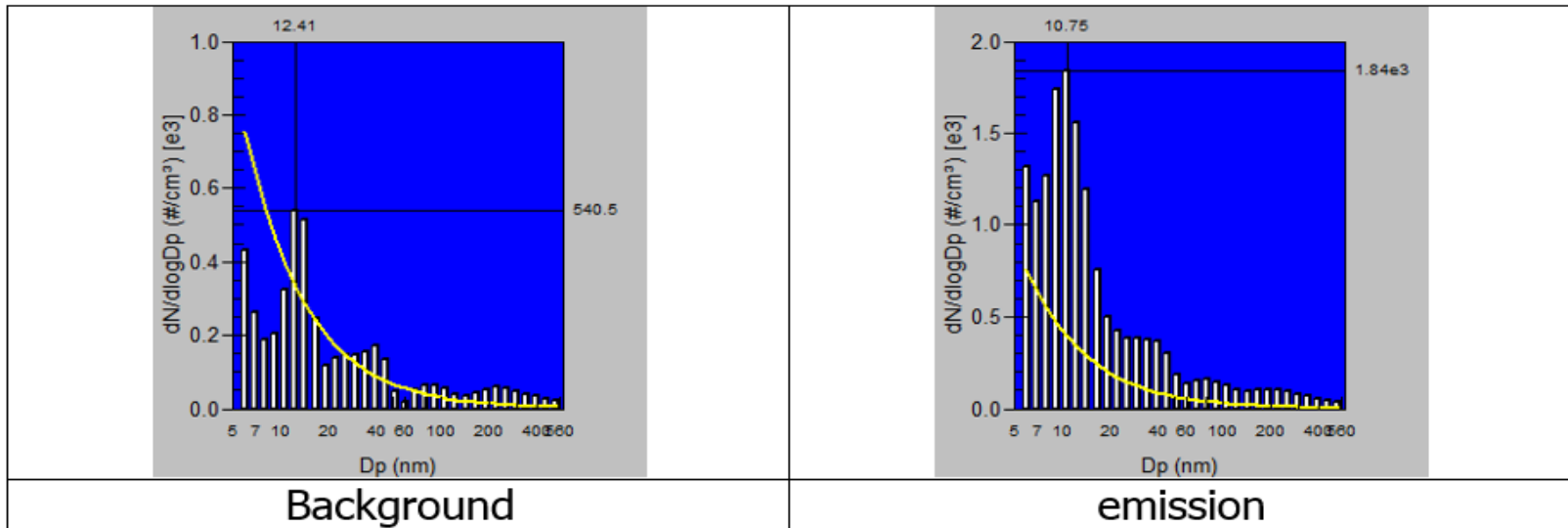
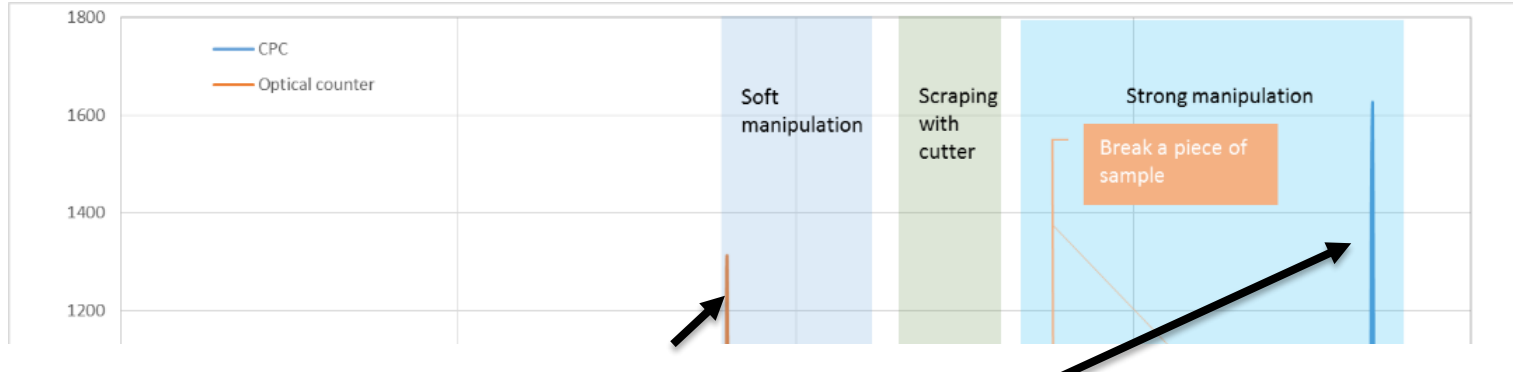
Scraping on CNT sample



## Particles concentration release as function of time for TiO<sub>2</sub> sample

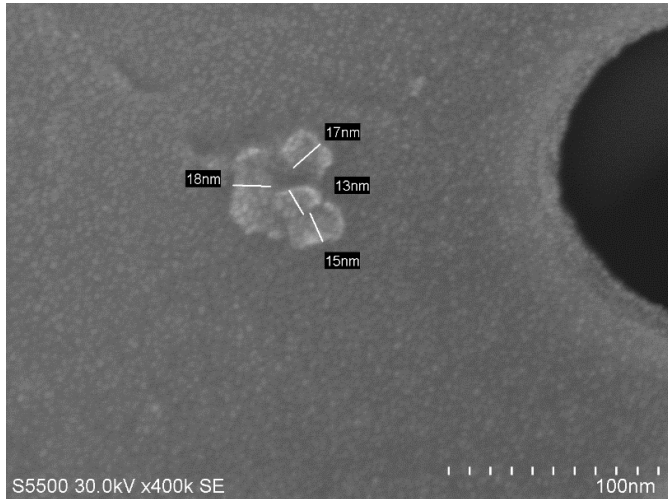


## Particles concentration release as function of time for CNT sample

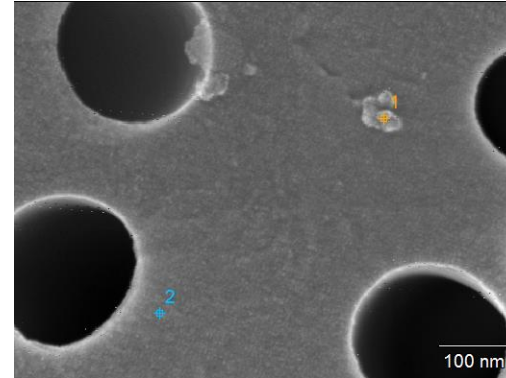


PSD during emissions the break of a piece - FMPS

## SEM Analysis of the sampling filters : Sample with a deposit of TiO<sub>2</sub> .



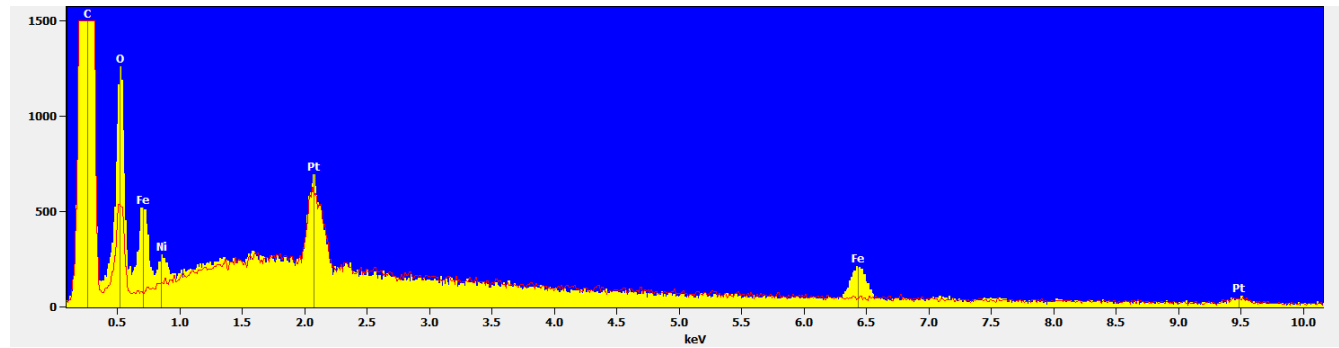
SEM image of the filter under 400 k magnifications



Nanometric particles on filter

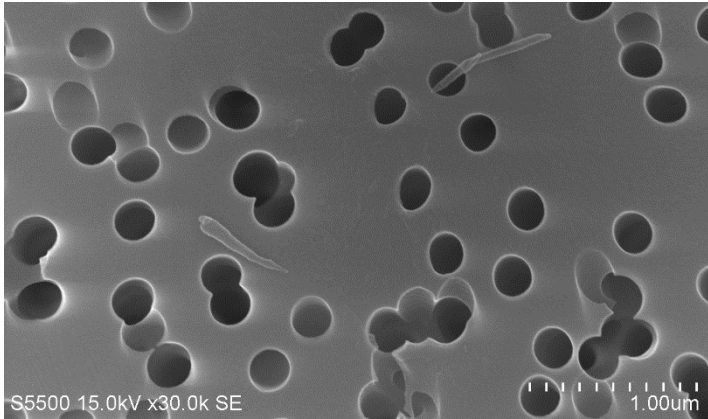
Point 1: iron and nickel  
Point 2: polycarbonate filter

EDX spectra:

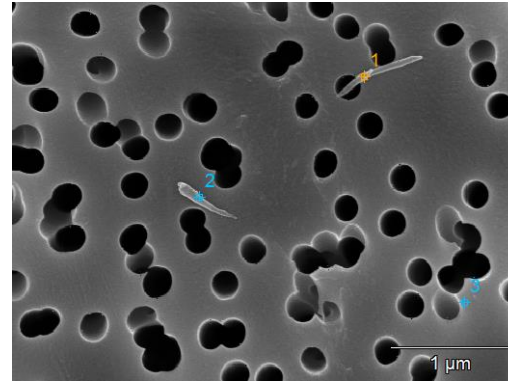


Nanometric particles on filter - Comparison between point 1 (yellow plot) and 2 (red graph)

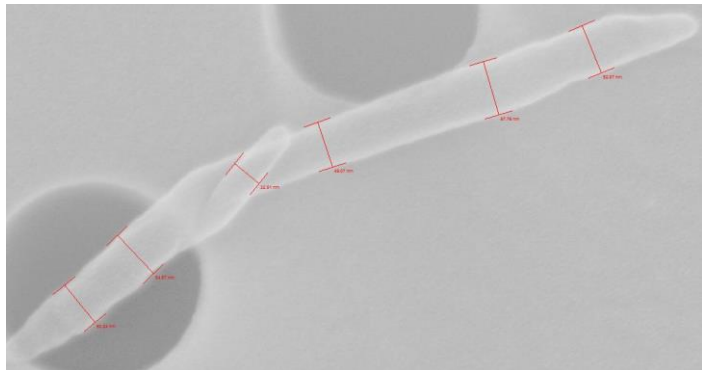
## SEM Analysis of the sampling filters : Sample with a deposit of CNT.



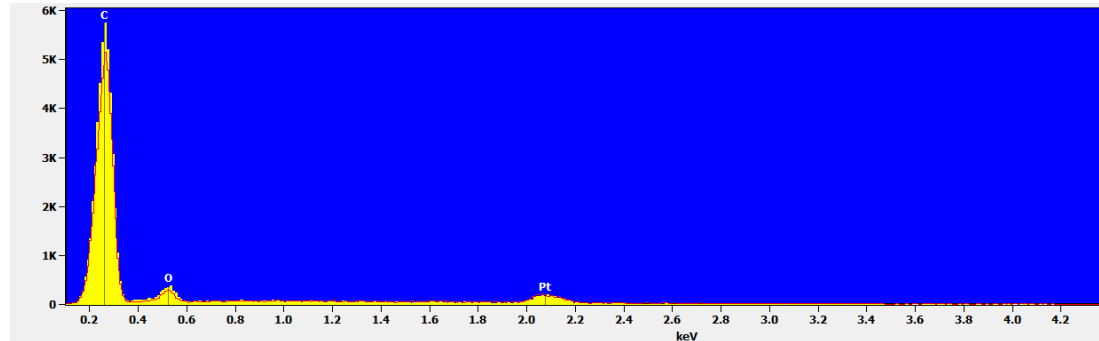
SEM image of the filter under 30 k magnifications



Point 1 and 2: carbon  
Point 3: polycarbonate filter



Determination of the diameter of fibers



Fibers on filter - Comparison between point 1 and 2 (yellow plot) and 3 (red graph)

## Guidelines for production, use and handling of nanopowders and nanocomposites as well as risk minimization procedures.

These investigated guidelines will help to:

- Develop site-specific methods that will protect workers and the environment,
- Offer reasonable guidance for managing the uncertainty associated with nanomaterials, whose hazards have not been determined and reducing to an acceptable level the risk of worker injury, worker ill-health and environmental impacts;
- Identify apparatus, procedures and personal and collective protective equipments aimed to minimize exposure for manufacturing apparatus, workers, in plant and external environment (powder and nanoparticles end of life, dismantling etc.).
- Define a safety procedure for production, handling and transport of NP.

## CO-AUTHORS:

Sebastien Artous  
Simon Clavaguera  
Dominique Locatelli

Juan Francisco Rodriguez  
(UCLM)  
Jose Luis Valverde  
Palomino (UCLM)

Isabel Rodriguez (IMDEA)

Cécile DUCROS  
cecile.ducros@cea.fr



# Thank you for your attention !



Commissariat à l'énergie atomique et aux énergies alternatives  
Centre de Grenoble | 38054 Grenoble Cedex  
T. +33 (0)4 38 78 44 00 | F. +33 (0)4 38 78 51 75

DRT  
CEAGRE  
SPNS

Etablissement public à caractère industriel et commercial | RCS Paris B 775 685 019