Exposure Assessment of Nanomaterials at production sites based on Short Time Sampling: Methodology & Strategy of the STS-EA approach

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The use of nanomaterials in various end products allows to achieve new and innovative properties which has resulted in their large scale deployment (Mitrano 2015; Piccinno 2012). Consequently, 300 000 to 400 000 european workers were potentially exposed to nanoparticles (NP) or their aggregate or agglomerate forms (NOAA) in 2012 (European Commission 2012).

A important aspect of the measurement campaign presented in this work is the sampling duration of the exposure assessment. Indeed, long-term sampling is generally recommended to assess toxicology data. Thus, many studies only provide results as daily exposure values. But NP or NOAA exposure are believed to be usually a succession of several short-term exposures (Pietroiusti 2014). Furthermore, in the absence of reliable nanotoxicology data, European stakeholders e.g. trade union groups ask for a zero exposure during particulate exposure (van Broekhuizen 2012). In addition, short-term aerosol measurements permit the identification of nanoparticle release points, thus designing source control at workplace.

In addition, to satisfy all these demands a relevant measurement strategy must be able to distinguish the NP or NOAA from the particulate background and to take into account the inhalable NOAA i.e. below 10 µm in size during a very short time of sampling. Therefore the assessment of exposure measurement should be able to deal with these issues and must be able to provide an adapted results analysis with practical recommendations of nanosafety to all stakeholders. Mini particle sampler is a new equipment making possible such an improvement (R'mili 2013).

The objective of the present work is to propose a global approach to assess the nanoparticle exposure assessment at workplaces (see figure 1). The methodology and strategy of the global approach is to carry out the measurement campaigns using the Short Time Sampling coupled with exposure assessment, namely STS-EA merge the tiered approach (Consent Report 2011) and the INERIS-CEA-INRS (INERIS - CEA - INRS 2012) approach. To validate the method the STS-EA approach has been tested on five different nanomaterials as NPs of zirconium dioxide (ZrO_2), titanium dioxide (TiO_2) and silver (Ag); polyamide nanofibers; and multiwalled carbon nanotubes (MWCNT) used in 6 different process lines.

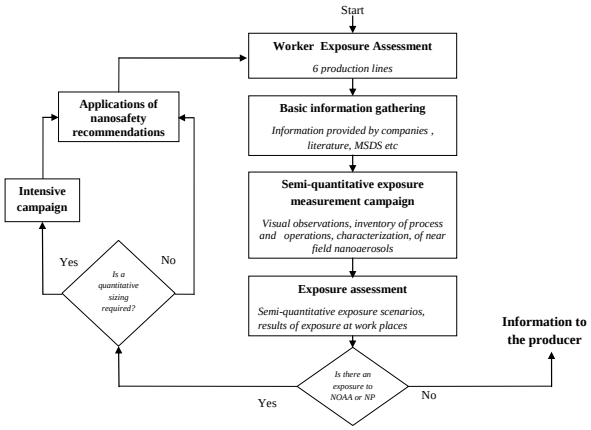

Figure 1. Schematic representation of the approach for Exposure Assessment at workplaces through STS-EA.

The STS-EA approach identified eight steps prone to short-term exposures of nanoparticles or NOAA out of total 37 steps distributed in six process lines. During the entire study, the leading potential exposure sources were found to be the steps like manipulation (nano-ZrO_2), spray (nano-Ag and nanoTiO_2) and cleaning (CNT, nano-Ag and nanoTiO_2) which were carried out at workplace. The process like spray drying (nano-ZrO_2) or electrospinning (TiO_2) which is generally carried out in a complete confinement was found to lead to no exposure.

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