Safe production and use of nanomaterials in the ceramic industry

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The ceramic industry is a growing industrial sector, which is benefitting from advances made available through nanotechnology and a number of innovative industrial processes. However, production of nanomaterials, including the manufacture and use of nanoceramics, cannot be considered safe without a thorough investigation regarding exposure and toxicity of nanoceramic materials, which is a current research gap. This requires better knowledge of workers' exposure in the ceramic sector and during nanoceramics manufacturing, handling and processing, which will firstly require the understanding of exposure scenarios. The comprehensive assessment of occupational exposure, toxicity and risk during the production and handling of nanomaterials has only rather recently become feasible, with the advent of new measurement techniques and first attempts towards harmonized measurement strategies (Asbach et al., 2015).

In this framework, our work aims to assess and improve environmental health and safety (EHS) in the ceramic industry. The objective of this work is to study industrial processes and activities which may generate nanoparticle emissions into workplace air, and to assess worker exposure by evaluating the particle release processes, characterizing the emitted particles, and understanding their toxicity. Two main types of exposure scenarios will be characterised during the nanoceramic value chain: (1) nanoparticle emission during production and application of engineered nanoceramics (e.g., Al-doped zinc oxide, La-based, $BaSO_4$, TiO_2 and silica nanoparticles, and ceramic pigments), and (2) nanoparticle emission during processes applied in the ceramic industry with potential for unintentional nanoparticle release, regardless of whether nanoceramics are used as input materials (e.g., laser ablation, plasma thermal projection, laser sintering of ceramic tiles, physical vapour deposition, and inkjet printing).

Nanoparticle release mechanisms and their impact on exposure will be characterised in a selected number of release scenarios, including morphologically and structurally characterising nanomaterials using state-of-the-art techniques for engineered nanoceramic particles and also for process-generated nanoparticles released to workplace air. Toxicity assessments will also be carried out for selected nanomaterials, with the aim to address biological interactions of nanoceramics, by performing in vitro and in vivo studies to provide insights on MNM toxicity profiles namely on those related with oxidative stress, inflammatory and genotoxic responses. Finally, we will develop a tool to discriminate engineered nanoceramic particles from background aerosols based on hygroscopicity measurements, thus innovating in the field of characterization methods relevant for EHS. Mitigation measures will also be proposed.

The work is currently ongoing in the framework of SIINN-ERANET project CERASAFE, which initiated its activities in January 2016. As project outcomes, a set of Good Manufacturing and Use Practices for nanoceramic materials will be established. Results will be collected in a public database complemented with risk assessment and including recommendations for industry, users and stakeholders to ensure the safe production process for nanoceramic materials.

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Asbach, C, et al. (2015) Measurement and Monitoring Strategy for Assessing Workplace Exposure to Airborne Nanomaterials in Safety of Nanomaterials along their Lifecycle - Release, Exposure and Human Hazards , Florida, US, CRC Press