Ensuring safety when scaling-up nano-based processes: the case of printed electronics

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Abstract
Scaling up nano-based processes is fundamental to ensure the growth of the nanotechnology-based industry and to attend market demands. The concept of Safe-by-Design underlines that safety should be considered in an integrated way right from the earliest phases of the research and innovation process. Following this concept, in this paper we present the work currently on going to achieve safe pilot plants for printed electronics. This work is being done inside the Horizon 2020 INSPIRED project (grant agreement nº 646155).

The strategy followed is described in Schimpel et. al (2017) [1]. It basically consists of a risk assessment approach that includes six steps (Figure 1): (i) Information Gathering; (ii) Hazard Assessment, to collect info on the nanomaterials toxicology; (iii) Exposure Assessment, to identify exposure scenarios for both, workers and the environment; (iv) Risk Characterisation, using state-of-the-art approaches and control banding tools such as ECETOC TRA, Stoffenmanager Nano and ISO/TS 12901-2:2014; (v) Refined Risk Characterisation and Exposure Monitoring, following the tiered approach proposed by the OECD (2015) [2]; and (vi) Risk Mitigation Strategies. This approach is implemented in all the processes involved in the life cycle of electronic inks from the synthesis of the nanomaterials to the final device end of life.

Results achieved up to now show that in general the processes have low risk ratios since nanomaterials are mainly handled in water dispersions and adequate engineering controls are kept. Workers' exposure in selected activities has recently been measured to check the appropriate performance of the implemented controls. More specifically, we monitored the graphene and silver nanowire synthesis and ink formulation handling. Data analysis is currently on going, but no relevant emissions of airborne particles in the workplace are expected. Results of this work will be presented.

Within the INSPIRED project, safety is considered during the scale up of printed electronics production; following this prospective approach, the potential impacts caused by the use of nanomaterials to workers and the environment can be effectively minimized.

References

[1] Schimpel, C., Resch, S., Flament, G., Carlander, D., Vaquero, C., Bustero, I., & Falk, A. (2017). A methodology on how to create a real-life relevant risk profile for a given nanomaterial. Journal of Chemical Health and Safety.
[2] OECD (2015) Harmonized Tiered Approach to Measure and Assess the Potential Exposure to Airborne Emissions of Engineered Nano-Objects and their Agglomerates and Aggregates at Workplaces, 2015.

Figures

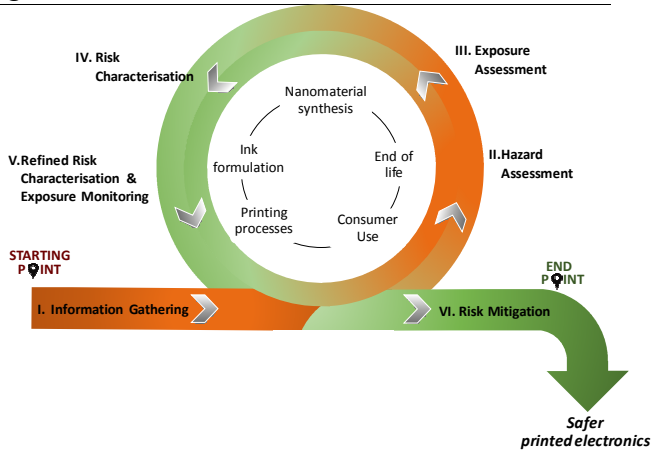

Figure 1: Strategy for risk assessment