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Publication date:
2013

Link back to DTU Orbit

Citation (APA):
Miseljic, M., Diaz, E. G. A., González Sánchez, G., & Olsen, S. I. (2013). Challenges in environmental sustainability assessment of metal nanomaterials. Poster session presented at VI International Conference on Surfaces, Materials and Vacuum, Merida, Mexico.

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Challenges in environmental sustainability assessment of metal nanomaterials (Poster presentation)

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Keywords: Engineered nanomaterials (ENMs), Life cycle assessment (LCA), environmental impacts, polymers

As a material class in a highly developing technology domain, engineered nanomaterials (ENMs) are used in many consumer products and the rapidly increasing level of application is underlining the need to include the whole product life cycle (from extraction of raw materials to the final disposal of a product after end of use) when assessing the environmental impacts of ENMs. Life cycle assessment (LCA), as an ISO-standardized sustainability assessment tool, can encompass the entire life cycle of products and systems, and yield quantitative environmental impact results that can be used in comparison with other comparable products or merely to provide an environmental hot-spot profile of a product [1] [2].

LCA was applied within the MINANO project to evaluate functionally enhanced polymers (PP, PVC-wood, PS) with either Ag, ZnO and $Mg(OH)_2$ ENMs or conventional additives to achieve improved antimicrobial/antifungal, UV-protection or flame retardant polymer functionality. The results showed that the ENM-based polymer products in general had a larger environmental impact than the polymer products with conventional additives. The higher impact is mainly a result of environmental impact during the production of ENMs. However, an increased product value and consequently a potentially longer use of a product can alter this so the ENM polymers could in theory outperform the conventional. Within LCA there are still challenges and uncertainties, among these are the lack of proper life cycle inventories and the potential release of ENMs to the environment and the resulting impacts these may have on the environment.

There are different challenges in performing a proper LCA on ENMs. Though the framework of LCA in principle is suitable for every product or system, it cannot yet properly evaluate the potential toxic impact of ENM release. Certain areas, as the fate of released ENMs into freshwater, are not well understood scientifically and therefore it is not possible to characterise the ENMs in terms of behaviour and effect these may lead to [3]. In this study the challenges in the LCA approach on the MINANO products are highlighted and more generally we address the difficulties that LCA has to prevail in order to be better suited for sustainability assessment of ENMs. The release of ENMs to the environment and their fate and effect is the hot topic nowadays, and in this study the fate and effect factors of a released ENM fraction in freshwater are modelled and subsequently the LCA characterisation factor of a metal ENM is calculated, as an example. The characterisation factor of an ENM can then be multiplied with the released amount of that ENM and the impact potential can be derived as the potential affected fraction (PAF) of living organisms in specified freshwater. The applied approach is derived from already published colloidal science, risk assessment and LCA based work on ENMs and should be considered as a preliminary approach.

Acknowledgment:

The authors would like to acknowledge that the research leading to these results has received funding from the European Community's Seventh Framework Programme under grant agreement n° 263946 in MINANO project.

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