Ecotoxicity of nano-carbon allotropes in X. laevis larvae, the choice of the right dose-metric

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Abstract

Among nanomaterials, carbon based nanoparticles (C-NPs) such as graphene; nanotubes or nanodiamonds are widely produced and used in many applications ranging from building materials as well as in the medical field. These nanoparticles could enter environment at each step of the life cycle of manufactured products and finally contaminates the aquatic compartment which is generally the final receptacle for the pollution. However there are still many questions many questions related to the potential toxicity of these nanoparticles and the difficulty to compare the results so far.

The objective of this work was first to assess the potential effects of different allotropes of nanocarbones. For this purpose, larvae from Xenopus laevis were exposed for 12 days to 4 types of C-NPs (few layer graphene, double-walled carbon nanotubes, multi-walled carbon nanotubes and nanodiamonds) using an international standardized bioassay procedure (ISO/FDIS 21427-1 2006). The second objective of this work was to find the most relevant dose-metric for quantifying the response of exposure to C-NPs that are different in their structure and morphology. Indeed, in most published articles dealing with nano-ecotoxicology, the results are expressed versus the mass concentration.

We show that this classical approach based on mass concentration fails to puzzle out the mechanisms of action which leads to toxicity with our biological model. Our results show that the toxicity of carbon nanoparticles is mainly driven by surface area, whatever the structure and the shape of carbon based nanoparticles. We propose a toxicity model based on surface area concentration of nanoparticles. Based on this metric, we suggest the calculation of a new ecotoxicological descriptor for nanoparticles toxicity assessment: the Areal Effective Concentration (AEC). This new parameter not only allows comparing the toxicity of carbon nanoparticles between them, but may also be used for the prediction itself of the toxicity.

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