Preparation of environmentally relevant nanoplastics (e-NPs), benefit for fate, behavior and ecotoxicology studies

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Abstract

Nanoplastics are emerging contaminants and the study of their fate, behaviour and environmental impact are a major concern. However, it is highly challenging to collect nanoplastics; thus, experimental studies of nanoplastic toxicity, fate and transport require the use of model nanoplastics. It is essential that model nanoplastic mimic as closely as possible the physicochemical properties of environmental NPs. This is particularly critical as the surface properties of the nanoplastics determine their colloidal stability and interaction with pollutants.

In this context, our study's objective was to produce an environmentally relevant model nanoplastic. Our approach was to extract nanoplastics from altered plastic in environmental condition, here, plastics were from the North Pacific garbage patch. The nanoplastic extraction was done by agitating and sonificating the plastic debris in an aqueous medium, abrading their altered surfaces. Then the suspension was sequentially filtrated at 40 μm and 1.2 μm, recovering the nanoplastics. Because natural organic was present on plastic debris, an optional step was developed to degrade it. The selective oxidation of organic matter was reached by the joint action of H2O2 and UV.

For the first time, we were able to characterize size, shape and the surface properties of relevant model nanoplastic using a range of techniques (Py-GCMS, ATR FTIR, potentiometric titrations, etc.). The produced model nanoplastic was mainly anisotropic particles of polyethylene and polypropylene, polydisperse in size, and presenting numerous ionizable groups at their surface. This allowed us to better understand the origin of their colloidal stability and metal reactivity, and thus their fate and behavior in the environment. This model nanoplastics was design for studying nanoplastic interaction with contaminants. But due to its environmental relevance, this model will benefit to other disciplines, especially these assessing nanoplastic risks as toxicology and ecotoxicology.

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