
Fabrication and characterization of (fluorescent) model nanoplastics for polymer specific detection

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Abstract

Nanoplastics are an emerging risk to animals, nature and humans, as their small size enables them to be transported through biological barriers that would filter out microplastics. However, detecting, characterizing and understanding nanoplastics is extremely challenging, as their size is smaller than the detection limit of common micro-spectroscopic techniques such as FT-IR or Raman micro-spectroscopy, and additionally their chemical nature makes them hardly distinguishable from organic matrices in which they are supposedly found. Nevertheless, rational exposure and health risk studies can be performed using model particles. Adding a fluorescent marker to these particles then even enables fluorescent microscopy as detection technique, making uptake and distribution studies easier. Prior to the synthesis of particles described in this work, we did an extensive literature study and found that 82% of the research done on fluoNPs is done on polystyrene (PS), as these particles are commercially available. To make a more realistic toolkit of model particles, we here present a nanoprecipitation method to generate PE, PVC, PET, PMMA and PS particles with a median size of ~ 100 nm. The particles are generated in high yields (50% of the starting material mass is recovered as NPs), and are all spherical-like but heterogeneous compared to the commercial (PS) beads. Depending on the application, one of two dyes was incorporated into the particles. PDI was used when the dye was required to have excellent stability concerning leaching behavior, whereas NileRed was used to give the different polymers a signature fluorescent spectrum. The latter was demonstrated by a feeding of PVC, PS and a mix of both particles to ciliates; demonstrating the ability to distinguish the different polymers within a single organism. The resulting particles from this work are widely applicable in nanoplastic research, as is evident from the usage in large Dutch and European consortia.

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