THE RELEVANCE OF PARTICLE CHARACTERIZATION FOR MICROPLASTIC IN THE ENVIRONMENT

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MOTIVATION
Looking at the microplastic challenge in the global water system, three main objectives are currently being addressed: 1) horizontal and vertical distribution in water bodies - transport behavior of particles, 2) toxicological effects due to the occurrence of microplastics in the environment and 3) identification of sinks (sites) of microplastics in global water bodies. Transport, toxicity and fate of polymers in the environment mainly depend on material properties. The properties are subject to constant change due to natural weathering processes (Figure 1). Depending on the research objective, various material parameters may be of interest. The horizontal and vertical distribution of polymers depends particularly on their density, size and shape. For toxicological considerations, parameters such as polymer type, presence of additives, but also size, shape, concentration and surface properties are of importance. In the following, several measurement methods are presented by which some of the aforementioned material parameters can be determined.

MATERIALS
For the experiments low-density polyethylene (LDPE, granules, ET316100), polyethylene terephthalate (PET, granules, ES306312; sheets, ES303010) and polystyrene (PS, granules, ET316100) with low additive contents were purchased from Goodfellow Cambridge Ltd. (UK). Cryomilling was used to produce LDPE and PET powder (pin mill, Alpine C160, Messer Group GmbH, Germany). The sheets were cleaned with ethanol and rinsed with ultra-pure water before measurements.

DENSITY
Density is an important parameter for transport processes and fate. For dry granules the density was determined by helium pycnometry and the results are presented in Figure 2. If one compares the densities of polymers with those of water, the following behavior in water are expected: PET sinks, PS floats in the water column and LDPE floats on the water surface. If polymer objects weather in water, a biofilm forms on their surface. This influences the density of the polymer. The exact density of a weathered sample can only be determined if the biofilm is not damaged. Dry samples are required for density determination by helium pycnometry, so this method is not suitable for weathered samples. Instead, a flotation test can be performed in suitable media. For LDPE samples, for example, an ethanol-water mixture is appropriate. Figure 2 shows two ethanol-water mixtures with different densities. Non-weathered LDPE granules were added to both media. The results show that the density of polymers can be determined very accurately with this method. Both, weathered and non-weathered samples can be measured with this method.

WEATHERING OF POLYMER SAMPLES
Artificial weathering in the laboratory LDPE and PET powder was used to prepare polymer suspensions (ρ = 4 g/l) based on artificial seawater (salt mixture, salt content 6 g/l, desinized water). The suspensions were weathered by using the experimental setup as previously described. The samples were exposed to UV radiation and mechanical stress (ms) for 28 days. Based on the UV conditions occurring in nature, this corresponds to a minimum weathering of 112 days in the environment. Weathering of the polymer sheets was performed by a research project partner (Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany).

Natural weathering LDPE and PET granules were placed for 9 month (Feb. 2017-Oct. 2017) in mesocosms in Oslo harbor by a research project partner (Norwegian geographical institute, NGI, Oslo, Norway). The setup design, preparation and “harvesting” was carried out by NGI.

CONCLUSION
The transport behavior, toxicological effects and the fate of microplastics are closely linked to their material properties. Therefore, the particle characterization is an important tool to detect changes caused by weathering and to find possible explanations for effects that are observed in nature.

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FURTHER INFORMATION

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