

Evaluation for Adsorption and Desorption Characteristics of Environmental Pollutants on Microplastics in Seawater

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Summary

The objective of this study was to clarify adsorption and desorption characteristics of heavy metals (arsenic: As, lead: Pb, and cadmium: Cd) on microplastics (polyethylene: PE, polypropylene: PP, and polyvinyl chloride: PVC). Both artificial microplastics after crushing and sieving up to 300-2,000 μm and reagent microplastics as commercialized chemicals (particle sizes not determined) were prepared and tested in the following experiments. Firstly, 1 g of each microplastic and 10 mL of artificial contaminated water containing each heavy metal were mixed and shaken for 24 h at 20°C. After centrifuging each sample, the supernatant was filtered using 0.45 μm membrane filter and analyzed for concentration of heavy metals. Following the adsorption experiment, 7 mL of the supernatant was removed. At the same time, 7 mL of ultrapure water was refilled, and each sample was again shaken for 24 h at 20°C. This desorption process was consecutively repeated two more times to obtain three desorption points after adsorption.

The supernatant obtained during the desorption experiment was also filtered using 0.45 μm membrane filter and analyzed for concentration of heavy metals. The adsorption and desorption data were evaluated using the Freundlich and Langmuir equations and the Freundlich equation, respectively. Adsorption of As was not significant, while Cd was slightly adsorbed. Especially, clear adsorption of Pb was observed. Maximum adsorption capacity for Pb was estimated as 5.5 $\mu\text{g/g}$, 11.8 $\mu\text{g/g}$, and 4.8 $\mu\text{g/g}$ for artificial PE, PP, and PVC, respectively. Because tested microplastics in this study probably have surface negative charge, Cd and Pb mainly present as cationic forms in water were significantly adsorbed. Adsorptive retention capacity for Pb after successive desorption processes were calculated as approximately 71%, 75%, and 90% for artificial PE, PP, and PVC, respectively. Clearly higher adsorptive retention capacity was observed specially for PVC. The adsorption and desorption mechanisms are needed to be clarified for further understanding behaviors of microplastics in water environment.