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The influence of iron (oxyhydr)oxides on the surface properties of polystyrene microplastics in aquatic environments

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The pollution of the environment by plastics has become one of the most emerging environmental issues over the past years. Especially micro- and nanosized colloidal particles are of environmental concern since they can be easily taken up by organisms and accumulate in the food chain. Hitherto, only little attention has been paid to the transformation and elimination processes of colloidal microplastic (MP) in the environment. In aquatic environments, colloidal MP will interact with natural constituents, such as metal (oxyhydr)oxides or organic matter. The reaction of those particles is strongly controlled by the surface properties of both, MP particles and the environmental particles. In this study, we investigated the interactions of polystyrene (PS) particles (diameter 1 µm) and ferrihydrite, a common ferric oxyhydroxide. PS particles were allowed to react with ferrihydrite for different reaction times (0h – 7d) at different pH values (pH 2-12) and constant ionic strength (10 mM). The surface properties of PS were examined before and after reaction with ferrihydrite using dynamic light scattering techniques. We observed that heteroaggregation between PS and ferrihydrite strongly depends on the pH value and reaction time. Heteroaggregation between PS and ferrihydrite was observed at environmentally relevant pH values. Maximal aggregation was found at the point of zero charge (pH = 6.5) and the aggregate size increased with time. Furthermore, the characteristic negative surface charge of PS at neutral pH values disappeared when PS and ferrihydrite were mixed in equal masses. Our observations clearly demonstrate that the surface properties of PS particles were modified through interaction with ferrihydrite. Overall, our research suggests that Fe(III)-(oxyhydr)oxides are highly important reactants to control the environmental behaviour of microplastic particles.