Title: Polystyrene Nanoplastics Induce Manganese Oxidation under Sunlight

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Much of the large quantity of plastics produced annually is discharged into the environment, where it degrades into tiny plastic debris (e.g., macro-, micro-, and nano-plastics). There are increasing concerns about the adverse effects of these plastics. In particular, nanoplastics are more prone to interacting with surrounding substances, because of their substantially larger surface areas and consequent increased exposure of surface functional groups. However, the oxidative roles of nanoplastics in inducing redox reactions with heavy or transition metals remain poorly understood. In this study, we investigated how Mn^{2+} was oxidized by the photolysis of polystyrene (PS)-based nanoplastics. We found that peroxyl ($ROO^{\bullet}$) and superoxide radicals ($O_2^{\bullet-}$) were generated during the photolysis of PS-based nanoplastics, and they were primarily responsible for Mn oxidation. In addition, different plastic particle sizes and functional groups influenced the formation of radicals and the growth and mineral phases of Mn oxide solids. This study provides insights into the occurrence and diversity of Mn oxides in nature. These new findings also enhance our understanding of the oxidative roles of nanoplastics in generating reactive oxygen species (ROS) and how this may apply to the oxidation of other redox-active metal ions and essential chemicals, which could disrupt ecosystems and affect elemental cycling. Moreover, the production of ROS from nanoplastics in the presence of light endangers marine life and human health, and also potentially affects the mobility of the nanoplastics in the environment *via* redox reactions, which in turn might negatively impact their environmental remediation.