

CHEMICAL CHANGES DURING AQUEOUS NANOPLASTICS DEGRADATION

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Nanoplastics from the Baltic Sea were chemically characterized and compared with laboratory generated polystyrene nanoparticles to understand their degradation under environmental-like conditions.

The presence of plastic material in the ocean is a major environmental problem and their occurrence and transformation in the environment is still unclear. Plastic material represents the main marine debris, and the size of this plastic debris can cover different orders of magnitude. Only recently, the presence of nanoplastics (NPs) in oceans has been demonstrated [1], and their environmental impact has remained elusive. Due to their low density, NPs are expected to float at the surface of the oceans and interact with both the atmosphere and the water body. Therefore, NPs can react with oxidants in the gas phase (e.g. ozone) and light. The objective of this project was to understand the degradation processes of NPs in the aquatic environment and to collect and analyze NPs from seawater.

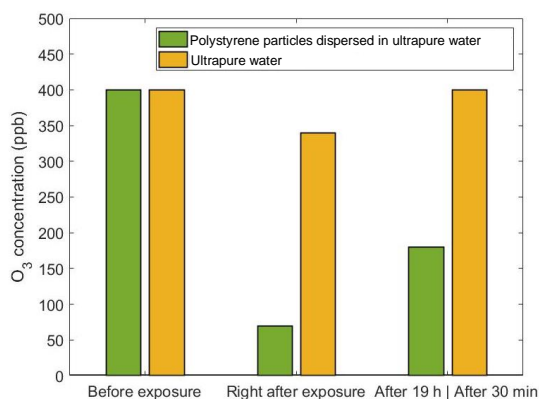


Fig. 1: Comparison between the ozone concentration at the entrance of the flow tube with that after the flow tube when either ultrapure water (yellow) and or PP dispersed in ultrapure water (green) were present in the flow tube.

We carried out experiments exposing commercially available polystyrene particles dispersed in ultrapure water to light or to ozone. The solution with polystyrene particles (PP) was placed in a flow tube and was irradiated with lamps or it was exposed to a flow of air containing 400 ppb of ozone. As shown in Fig. 1 we observed a significant uptake of ozone into the polystyrene particles, also after 19 hours of exposure. This result highlights that NPs at the surface of water can interact with oxidants in the gas phase, such as ozone. To understand the effect of ozone uptake and the interaction with light on polystyrene particles we analyzed them by Scanning transmission X-ray microscopy (STXM) coupled to near-edge X-ray absorption fine structure spectroscopy (STXM/NEXAFS).

We observed for both samples (PP exposed to light and PP exposed to ozone) the presence of oxygenated functions in the particles, showing that these plastic particles dispersed in water can react with both light and ozone.

We also collected particle samples from the Baltic Sea (Gulf of Finland) and we analyzed them by STXM/NEXAFS. We collected seawater in Helsinki's harbor, and we filtered the water on several filters with different mesh size. Finally, we extracted particles from the filters that were soluble in organic solvents, nebulized the solution and impacted the droplets onto sample substrates. The sample was analyzed by STXM/NEXAFS and as shown in Fig. 2 different regions can be identified in the analyzed particle. The red color (Fig. 2) refers to the peak at 285 eV corresponding to C=C double bonds that could be a characteristic indicator for plastic. These preliminary results show evidence for the presence of NPs in the seawater sample and promising for further studies on NPs in the environment and their reactivity.

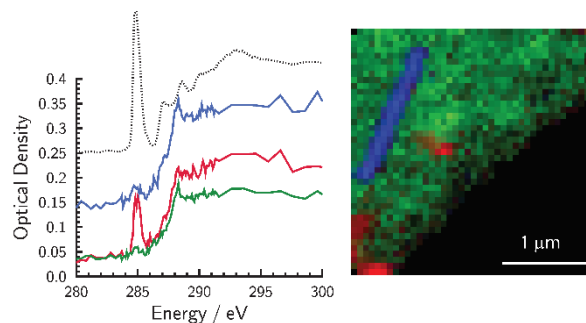


Fig. 2: X-ray spectra and image of plastic extracted from natural seawater. Spectra in the left panel are shown as blue, green and red colors, which correspond to the spatial regions in the colorized X-ray image in the right panel. For comparison, the reference spectrum of polystyrene spheres from a blank experiment is shown as the dotted line in the left panel.

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[1] A. Ter Halle et al., *Environ. Sci. Technol.*, **51**, 13689-13697 (2017).