Short-term degradability of plastic in the marine environment

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Abstract

Understanding plastic degradation is crucial to evaluate the retention time of plastic waste in the environment, their fragmentation rate into harmful microplastics, and therefore their potential impacts on the ecosystem. This study aims to evaluate the short-term degradability of seven commonly used conventional plastic polymers – namely PET, HDPE, PVC, LDPE, PP, PS and EPS, in the marine environment. Short-term experiments of 40-day incubation with intensive sampling were conducted at 2 sites with different levels of exposure, and in Winter and Summer respectively in order to assess the roles of different environmental stressors (e.g. temperature, light irradiation, and microbial action) in plastic degradation. In this study, degradation behaviours of the plastics were characterized by the changes in their physical and chemical properties, by means of visual inspection, mass change, contact angle test, Fourier-transformation infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). No significant mass loss in plastics was recorded in our experiments. Yet, significant changes in the oxidation status of plastics were recorded, with an oscillating trend observed within 40 days of incubation. Rates of increase and decrease in oxidation status were found the highest mostly before the settlement of macrofoulers, suggesting the potential shielding impacts of macro-biofouling on plastic degradation. Also, among all plastics, EPS demonstrated the largest changes in oxidation status. Our result highlighted the short-term degradability of conventional plastics, while the oscillating oxidation status suggested the synergistic effects of oxidative degradation followed by biodegradation (i.e. full degradation) or fragmentation (i.e. partial degradation) in a short term. The results implied the need to adjust our expectations towards the degradation potential of the 'non-degradable' conventional plastics, and the attention required to address the potential short-term plastic fragmentation.

Keywords: conventional plastic, short term degradability, oxidation, marine environment

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