Evaluation of photodegradation of microplastics in the atmosphere by using model substances

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Microplastics (MP) are plastic debris less than 5 mm in size and have attracted attention for their adverse effects on various environments. However, MP in the atmosphere have been less studied than those in the ocean. Several studies have pointed to the risks of atmospheric MP for human health through inhalation or ingestion, but much remains unknown. When atmospheric MP are exposed to sunlight, their physical and chemical characteristics change: this is called photodegradation in this study. The health effects of MP can be different before and after photodegradation. To understand these effects in the laboratory, appropriate model particles are needed.
In this study, we 1) made photodegraded MP particles by irradiation of simulated sunlight and 2) investigated changes in surface morphology and eluted compounds after photodegradation by using three model substances, polyethylene terephthalate (PET), polypropylene (PP) and polystyrene (PS), Observation using scanning electron microscope (SEM) showed no obvious surface morphology change on the surfaces of PET and PP, while there was an apparent change in the surface morphology of PS, and holes and cracks were observed in the light-irradiated PS particles. Analysis with high performance liquid chromatography (HPLC) showed no elution of compounds after light irradiation for PP. On the other hand, elution of several compounds was confirmed from PET and PS after light irradiation. As a result of comparison with standard reagents, elution of terephthalic acid and benzoic acid from PET and benzoic acid from PS has been confirmed so far.
SEM observations and HPLC analysis revealed that PS was poorly resistant to sunlight. PET showed no change in morphology after light irradiation, but multiple eluates were found in the samples after light irradiation. These compounds were eluted by photodegradation and are thought to be Norrish Type II of the degradation process. No morphological changes were observed in PP, and no eluates within the range measurable by HPLC could be identified. PP was considered to be less affected by photodegradation because the polymer backbone does not contain unsaturated bonds that absorb light energy.
The study was able to evaluate the photodegradation of three model plastic particles. As for eluates, there may be substances that cannot be identified by HPLC, so it is necessary to determine them using other analytical methods in the future. It is also necessary to understand the decomposition process.

Keywords: Micro plastic, Photo degradation, Polyethylene terephthalate, Polystyrene, Polypropylene

