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Organic Contaminants Released Form Plastics

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Extended Abstract

Plastics materials are known to release and spread organic contaminants in the environment. The generalized contamination by these materials occurs after adsorption and spreading of coexisting organic contaminants such as polycyclic aromatic hydrocarbons [1], by releasing plastics additives such as plasticizers, antioxidants, and flame retardants, and also by releasing products resulting from the degradation of the polymer matrix. As plastics are generally considered stable materials, this last contribution to environmental contamination has been overlooked. However, thought proceeding at low rates [2], plastics undergo degradation, which leads to formation/release of microplastics, nanoplastics and organic molecules. Plastics of all sizes are therefore exposed to degradation and potentially release organic compound in the environments contributing to their generalized contamination.

The main abiotic degradation pathways include thermal oxidation and photooxidation. Both reaction types are radical processes, starting by the formation of carbon centred radicals on the plastics surfaces, which then react with oxygen leading to a cascade of reactions that ends with the incorporation of oxygen in the polymer structure. Released compounds result from multiple scissions of polymer chains.

We have been studying the thermal and photochemical oxidation of microplastics on surfaces. Due to its exposure to both, sunlight and temperature in environmental conditions, we have been studying the degradation of these materials on beach sand surfaces. Both gas-phase released products and non-volatile compounds have been studied under thermal degradation and lamp irradiation conditions. Products released to the gas phase have been studied by SPME-GC-MS while the non-volatile compounds remaining on the surfaces have been analysed by LC-HRMS. The profiles of compounds obtained by LC-HRMS were processed and analysed using Compound Discoverer 3.3^{TM} software.

In this work we present results of the thermal and photochemical transformation of polyethylene (PE), Polystyrene (PS) and polyvinylchloride (PVC) on sand surface in the presence and absence of oxygen. For comparison purposes results obtained using pure materials and adsorbed on silica surface are also presented. Main compounds were identified using standards or annotated based on libraries and/or mass spectral data.

For each plastic material, the photoproduct distributions and degradation kinetics depend on the reaction conditions. The photodegradation products depend on the light source (Hg or Xe lamp) and on the surface. As for photodegradation, the thermal degradation depends on the degradation temperature and on the surface. As expected, compounds possessing oxygen in their structure decreased in the absence of molecular oxygen (nitrogen atmosphere). Although both thermal and photochemical oxidation are radical processes and involve similar intermediates, the products distributions observed after each process are significantly different. Main differences were assigned to secondary photodegradation of primary photoproducts.

References

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