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Studying the Photodegradation Behavior of Microplastics Released from Agricultural Plastic Products to the Farmland

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Abstract : The application of agricultural plastic products like mulch, greenhouse covers, and silage films is increasing due to their economic benefits in providing an early and better-quality harvest. In 2015, the 4 million tons (valued a 10.6 million USD) global market for agricultural plastic films was estimated to grow by 5.6% per year through 2030. Despite the short-term benefits provided by plastic products, their long-term sustainability issues and negative impacts on soil health are not well understood. After their removal from the field, some plastic residuals remain in the soil. Plastic residuals in farmlands may fragment to small particles called microplastics (d<5mm). The microplastics' exposure to solar radiation could alter their surface chemistry and make them susceptible to fragmentation. Thus, this study examined the photodegradation of low density polyethylene as the model microplastics that are released to the agriculture farmland. The variation of plastic's surface chemistry, morphology, and bulk characteristics were studied after accelerated UV-A radiation experiments and sampling from an agricultural field. The Attenuated Total Reflectance Fourier Transform Spectroscopy (ATR-FTIR) and X-ray Photoelectron Spectroscopy (XPS) demonstrated the formation of oxidized surface functional groups onto the microplastics surface due to the photodegradation. The Differential Scanning Calorimetry (DSC) analysis revealed an increased crystallinity for the photodegraded microplastics compared to the new samples. The gel permeation chromatography (GPC) demonstrated the reduced molecular weight for the polymer due to the photodegradation. This study provides an important opportunity to advance understanding of soil pollution. Understanding the plastic residuals' variations as they are left in the soil is providing a critical piece of information to better estimate the microplastics' impacts on environmental biodiversity, ecosystem sustainability, and food safety.

Keywords : soil health, plastic pollution, sustainability, photodegradation
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