Electron beam technology for improved detection of microplastics

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The study of microplastics is crucial for the achievement of several Sustainable Development Goals (SDGs), as it contributes to the understanding of the resulting health risks (SDG 3) and facilitates measures to mitigate them. It can contribute to enhances water quality (SDG 6) by more precise detection and removal of microplastics from water sources and contributes to the protection of aquatic (SDG 14) and terrestrial habitats (SDG 15) by improving our understanding of their impact on ecosystems.

Although microplastic pollution is a global environmental issue, analysis still poses a challenge. While most established methods, such as Raman microscopy and TED-GC-MS, are very time-consuming and costly, differential scanning calorimetry (DSC), after prior enrichment by electrostatic separation, requires less time and investment, and thus is assumed to be a routine-capable method [1]. However, the separation of polymer mixtures with overlapping DSC signals, in particular HDPE and PP, is a problem that affects two of the most commonly used polymers [2].

To address this issue, we investigated the effect of electron treatment on their separability in electrostatic separation. The microplastic particles of HDPE and PP were obtained by cryo-milling and carefully mixed in accordance with the relevant standard operating procedures. The mixture was then transferred to a Petri dish with a film tensioner, creating a monolayer of microplastic particles. The mixture was then subjected to electron beam treatment at doses ranging from 0 to 300 kGy. After designated relaxation periods ranging from one to 48 hours, the mixture was transferred to a corona roller separator, resulting in a separation of the mixture into two distinct fractions.

The results demonstrated that fractionation of HDPE and PP in a corona roller separator is possible after electron beam pretreatment. The different storage properties of absorbed primary electron charges during low-energy electron beam pretreatment create the potential for the separation of HDPE and PP under optimal irradiation and storage conditions.

The results offer valuable insights into the differential enrichment of HDPE and PP and are not only pertinent to the analysis of microplastics, but also to the optimization of plastic recycling, particularly with regard to the pretreatment of plastic waste with electron beam radiation.

References:

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