Recycling Polyolefin Films via Field-Assisted Extrusion

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Flexible polymer films have an increasing share of the single-use packaging market. The recycling rate for these films remains low due to challenges in collecting and handling this film, but also because many films contain multiple layers, and the compositional complexity degrades the quality of secondary feedstocks. Linking innovations in separations, characterization, and product redesign with advanced processing capabilities in the plastics supply chain will be key to scaling circular economy innovations. This work describes state-of-the-art extrusion approaches for recovering value from flexible films and mixed plastic packaging waste streams that are particularly challenging to recycle. The first case study describes ultrasonication-assisted extrusion of polyethylene to manipulate the crystalline structure in pursuit of improved gas barrier properties without additional polymer layers. A custom-built sonication die is employed for controlling the dynamic temperature and shear environment, resulting in flow-induced crystallization. A second case study investigates compatibilization via gamma irradiation to induce free radical reactions in polymer blends. The residual radical centers induce grafting that alters the blend morphology and properties. The relationships between extrusion processing parameters, polymer structure, and performance are explored using spectroscopy, rheology, and scattering. These case studies show that melt processing is an efficient and adaptable approach for achieving property improvements in mixed waste streams, and for producing films that are more sustainable by design.