Molecular Recycling of Plastics Facilitated by Solvents

Authors (in alphabetical order) and their Affiliations
Paschalis Alexandridis,[1,2] John D. Atkinson,[2] Christian Ferger,[1] Ali Ghasemi,[1] Jacob Licht,[1] Zeinab Mousania,[2] Shikha Solanki,[1] Marina Tsianou [1]
(1) Department of Chemical and Biological Engineering, and (2) Department of Civil, Structural and Environmental Engineering, University at Buffalo, The State University of New York (SUNY), Buffalo, NY 14260

Corresponding Author
Prof. Marina Tsianou, Department of Chemical and Biological Engineering, University at Buffalo, The State University of New York (SUNY), Buffalo, NY 14260-4200, <mtsianou@buffalo.edu>

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Abstract:

Only a small fraction of the plastics produced is being recycled, with the great majority landfilled or released into the environment. Mechanical recycling is currently used to recycle plastic, however, this method is efficient only for homogeneous and non-contaminated feedstock, and for easily identifiable objects such as bottles made of PET or HDPE. Notably, mechanical recycling cannot easily handle plastic films which constitute about 40% of all plastic packaging used. Polyolefins in the plastic waste stream can be processed via pyrolysis, the most common among chemical recycling processes. Pyrolysis, however, decomposes the polymers, resulting in undesirable greenhouse gas (GHG) emissions. Further, pyrolysis is not viewed as constituting recycling when its product, pyrolysis oil, is not converted into new polymers.

Plastics recycling research in our group utilizes physical, solvent-based processes that do not break down the polymer chains. This constitutes true recycling, as the recovered polymer is the same as the starting material. Such molecular recycling processes leave the polymer chains intact, thus maintaining their embodied energy and emitting relatively little GHG.

Examples on molecular recycling are highlighted on the (i) separation of polyolefin mixtures through dissolution/precipitation in solvents that switch between a form that dissolves polyolefins and another that does not, hence facilitating the cycling and reuse of the solvent, and (ii) recovery of polyethylene from multilayer films via solvent-assisted delamination and separation, which retain the majority component, polyethylene, in the solid form, hence reducing greatly solvent amounts. The recovered polyolefins, following appropriate processing, can replace primary materials without loss of properties or performance and, hence, meet demand by customers and corporations to incorporate recycled plastics into products.

Pop art image of chemical recycling generated by Microsoft Copilot.

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