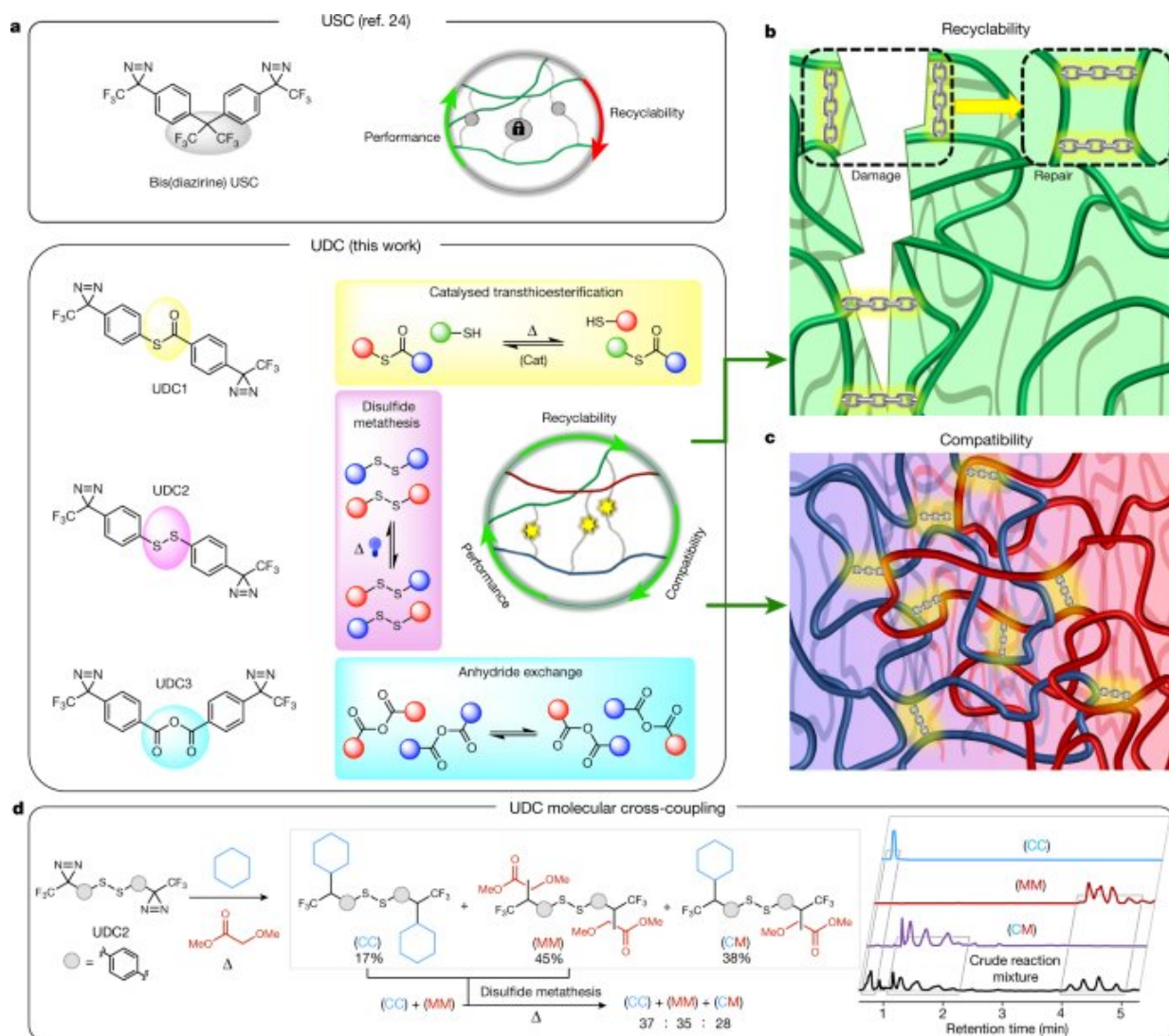


Chemists tackle the tough challenge of recycling mixed plastics

April 26 2023



Design of UDCs and their molecular and macromolecular features. Credit: *Nature* (2023). DOI: 10.1038/s41586-023-05858-3

Plastics are everywhere in our daily lives, but not all plastics are created equal—far from it.

Take, for instance, polyethylene terephthalate, a plastic used to make soda bottles and clothing fibers. Then there's [high-density polyethylene](#), from which shampoo bottles, milk jugs and cutting boards are derived. Don't forget polystyrene for packaging, or low-density polyethylene, which gives us cling wrap and grocery bags.

All of these are plastics, which are the most widely used types of polymers—macromolecules made of repeating units of [small molecules](#) called monomers. Post-consumer plastics are almost always collected as a mixed stream of waste, and products are often manufactured from two or more types of plastics.

The bad news is that these items, though all "plastics," are chemically and physically incompatible, and there's no good industrial method for reusing or re-processing them into other useful products. That's why most of those "recyclables" you're throwing into bins every week are going to a landfill. Even after careful sorting and separation into individual plastics, mechanical recycling usually yields inferior products, termed down-cycling.

Polymer chemists at Colorado State University have long been leaders in finding ways to tackle the environmental problems humans have created with plastics waste. Now, they've come up with fundamental new chemistry that seeds a creative solution to the challenge of recycling mixed-use plastics.

Led by University Distinguished Professor Eugene Chen in the Department of Chemistry, and Tomislav Rovis and Sanat Kumar,

professors at Columbia University (Rovis was formerly a faculty member at CSU), the team has devised a new chemical strategy that delivers specifically designed small molecules called universal dynamic crosslinkers into mixed plastic streams.

These crosslinkers transform a former muck of unmixable materials into a viable new set of polymers, which can be turned into new, higher-value, re-processable materials, a process known as upcycling. The work is published in the journal *Nature*.

Dynamic crosslinkers

When heated and processed together with the dynamic crosslinkers added in small amounts, the mixed plastics are made compatible with each other through in-situ formation of a new material, called a multiblock copolymer.

Kumar likened the [block copolymers](#) to soap molecules, which make water compatible with oily dirt molecules. "In a similar way, these new types of dynamically formed 'soaps,' i.e. the block copolymers, compatibilize mixed plastics and make them usable as a new kind of material with useful properties."

This new method of upcycling, which does not involve deconstructing or reconstructing any of the original polymers, introduces a potential solution for recapturing materials and energy endowed in post-consumer mixed plastics that typically end up in landfills.

The team designed their crosslinkers and tested them on a variety of plastics, including samples of mixed polyethylene Ziploc bags and polylactide cups without prior purification or removal of additives or dyes, which are typically present in post-consumer plastic products. They combined their experiments with modeling studies to verify that the

crosslinkers induce the formation of new multiblock copolymers.

"The system is so efficient, it compatibilizes three different polymers into a single new material," Rovis said.

Multiple use cycles

The researchers posit that their new strategy could help achieve the ultimate goal of reusing mixed plastic waste over multiple use cycles, Chen said.

"A key barrier is cost; we are talking about millions of tons of plastic waste, and you have to consider how many of these dynamic crosslinkers you need, although we currently need only less than 5% of the weight of the [plastics](#) in our upcycling process. Like many fundamental discoveries made in history, practical obstacles exist at the very beginning, but we are very excited about future potential."

More information: Clarke, R.W. et al, Dynamic crosslinking compatibilizes immiscible mixed plastics, *Nature* (2023). [DOI: 10.1038/s41586-023-05858-3](https://doi.org/10.1038/s41586-023-05858-3).
www.nature.com/articles/s41586-023-05858-3

Provided by Colorado State University

Citation: Chemists tackle the tough challenge of recycling mixed plastics (2023, April 26) retrieved 24 April 2024 from <https://phys.org/news/2023-04-chemists-tackle-tough-recycling-plastics.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is

provided for information purposes only.