Students lead polymer research into more recyclable plastics

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Chemistry and material science researchers at Colorado State University have developed a new class of recyclable polymers that could replace common single-use plastics with a large environmental footprint like grocery bags.

The work—described in a new edition of *Science*—was led by Chemistry Professor Garret Miyake in partnership with the National Renewable Energy Laboratory. In the paper the team describes an approach to create a series of polymers that display a diverse range of sought-after properties, are highly recyclable and can be made with just two simple building blocks.

Postdoctoral Fellow Yucheng Zhao is the co-first author on the new paper. He said that polyolefins are popular for current plastic needs because of material properties that make them easy to shape and durable, but also make them hard to recycle after use.

To address that gap, the team developed an approach to make chemically recyclable polyolefin-like materials from two "hard" and "soft" building blocks. Those new synthesized polymers remain suitable for a wide number of uses based on their mechanical properties like flexibility and strength. Additionally, the materials can be recycled without separation, which is currently a major challenge in recycling mixed plastics.

They also feature other sought-after traits, like a high melting temperature and low gas transition temperature, and can be deconstructed back into the basic blocks again for recycling, said Zhao.

Emma Rettner is a Ph.D. student in the Materials Science and Engineering Graduate Program and was also a co-first author on the paper. She said this is the kind of work she had hoped to be a part of when she came to CSU, based on the university's reputation around sustainability research.

"We use polyolefin plastics every day, but we still have a lot of unanswered questions about what to do with them when we are done," she said. "Our method makes a potential replacement class of polymers much more accessible for study and potential use. It opens a new area of materials to explore that could eventually address key sustainability and recycling issues around plastics."

Katherine Harry also served as an author on the paper and is working on her Ph.D. in the Department of Chemistry.

"The best part of this work was realizing so many new areas to study branching from our initial efforts," she said. "One of the most exciting directions that I hope to pursue next is discovering new catalysts which have even lesser environmental impacts than the ones we already know to work now."

More information: Yucheng Zhao et al, Chemically recyclable polyolefin-like multiblock polymers, *Science* (2023). DOI: 10.1126/science.adh3353

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