

Rewriting the reactivity rules: A new catalyst for recycling mixed plastics

Japanese researchers have developed a catalyst that selectively degrades polyurethane in mixed plastic waste, opening a practical route to recycling materials long considered too complex to separate

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Fukuoka, Japan—Ever wondered where your plastics end up? A PET bottle can be washed, shredded, melted, and given a second life. But most everyday items—toys, mattresses, car seats—are made from different plastics that refuse to mix when melted, producing unusable, contaminated material. Sorting is difficult and expensive, so most mixed plastic waste ends up burned or buried, and the materials are lost for good.

On 9 July 2026, a Japanese research team reported a potential solution in *Angewandte Chemie International Edition*, which the journal selected as a Hot Paper. Using a newly developed catalyst and hydrogen gas, they selectively broke down polyurethane (PU) in mixed plastic waste, leaving coexisting polyester and polyamide materials intact for further processing and recycling.

“PU is the sixth most widely used polymer, found in textiles, sponges, and car seats, yet it remains largely outside the reach of recycling systems,” explains Professor [Takanori Iwasaki](#) of Kyushu University’s [Faculty of Engineering](#). “Unlike PET, it does not melt when heated, so we need to break the chemical bonds directly.”

The challenge is that PU is almost always blended or bonded with polyester and nylon in real-world products. Existing chemical methods break down PU but damage the other materials in the process, making separate recovery impossible.

Iwasaki, together with researchers at the University of Tokyo and Japan’s National Institute of Advanced Industrial Science and Technology, found a way around this. By combining an iridium-based catalyst with a phenolate salt—an activator for iridium catalyst—and using hydrogen gas at 130–170°C, the team successfully degraded PUs in mixed plastic waste while coexisting polyester and nylon remained completely unchanged.

“What I find most remarkable is that it overturns what every undergraduate learns in organic chemistry,” notes Iwasaki. In standard chemistry, esters are more reactive than amides, and amides more reactive than urethanes. This means polyester should break down before nylon, and nylon before PU. “By combining iridium catalyst and the right additive, we flipped that sequence entirely. The least reactive bond gets cut first, while the more reactive ones are left untouched.”

Beyond laboratory experiments, the team tested the method on real commercial products. A kitchen sponge and blended underwear, containing PU alongside polyester and nylon, were successfully treated, with the PU breaking down into reusable components while the polyester and nylon stayed intact. The method also worked on a mobile phone case and an end-of-life car seat.



Fig.1. Rewriting the reactivity rules: A new catalyst for recycling mixed plastics

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As the process achieves material separation and chemical recycling in a single step, it opens new possibilities for waste long considered too complex to handle. The team sees particular promise in end-of-life vehicle recycling and mattress disposal, two industries generating enormous volumes of PU waste with limited recycling solutions today.

The research also speaks to a broader tension in materials design. Faced with recycling difficulties, manufacturers increasingly replace high-performance materials with easier-to-recycle alternatives. “Japan’s Shinkansen trains are a good example,” adds Iwasaki. “Newer models have replaced PU seat cushions with polyester. It is easier to recycle but noticeably less comfortable. If we can handle mixed plastics properly, manufacturers no longer need to make that trade-off.”

The team acknowledges that cost and scalability remain to be addressed. Iridium, the metal at the heart of the catalyst, is rarer and more expensive than gold. Finding more affordable alternatives and improving catalytic efficiency are essential next steps.

“Plastic recycling is only the beginning,” reflects Iwasaki. “As an organic chemist, what excites me most is the ability to selectively override chemical reactivity rules. My hope is that this opens more bridges between fundamental chemistry and real-world problems, from plastic waste to pharmaceutical synthesis and beyond.”

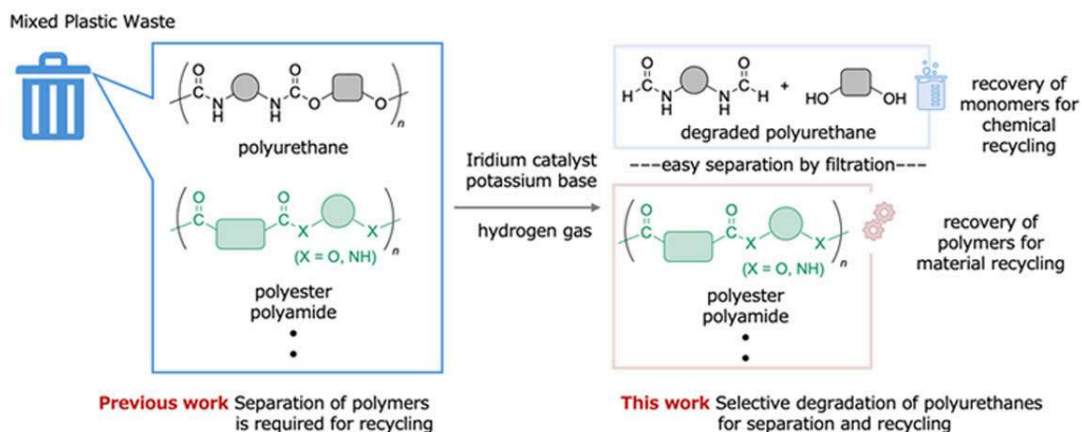


Fig.2. Selective degradation separates polyurethane from mixed plastic waste in one step

Mixed plastic waste often contains polyurethane tangled together with polyester and nylon, and these materials normally have to be separated before recycling can happen. Using a new catalyst and hydrogen gas, researchers selectively broke down the polyurethane into small, reusable molecules, which were then easily separated from the intact polyester and nylon by simple filtration. The process achieves separation and chemical recycling in a single step, opening new possibilities for waste long considered too complex to handle.

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For more information about this research, see “Selective Degradation of Polyurethanes in Mixed Plastic Wastes via Ir-Catalyzed Hydrogenolysis,” Yuto Yamada, Takanori Iwasaki, Shinji Tanaka, and Kyoko Nozaki, *Angewandte Chemie International Edition*, <https://doi.org/10.1002/anie.4288189>

Research-related inquiries

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