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Vulcanized thermoset materials based on intrinsically recyclable polymuconate derivatives

Novel bio-based thermosets are compatible with standard vulcanization processes, offering a scalable and sustainable rubber alternative that can be efficiently depolymerized to recover original monomers.

Conventional rubbers present a significant recycling challenge due to their covalently cross-linked structure created during the vulcanization process. This type of network makes them chemically inert and resistant to traditional recycling methods. Researchers at Purdue University have developed a novel class of recyclable thermosets derived from bio-based muconate esters (PolyMEs), which can be vulcanized using standard industrial processes to achieve the desired mechanical properties and durability of conventional rubber. This innovation addresses a long-standing environmental challenge and provides a scalable, sustainable alternative for the rubber industry. Unlike traditional thermosets, the polymer backbone of these PolyMEs remains intact during vulcanization. This feature allows an efficient depolymerization at a moderate temperature of approximately 250Â°C, recovering the original monomers and oligomers.

Technology Validation:

CBS-crosslinked PolyME-BuPe-5050 yielded a recovered monomer containing 42% pentenyl and 58% butyl groups, with an overall monomer yield of 29%. In contrast, the lower substituted PolyME-BuPe-7525 yielded only 10% pentenyl content in the recovered monomer but exhibited a higher overall recovery yield of 38%, likely due to the reduced crosslink density.

Advantages:

-Recyclability

-Compatibility with industrial processes

-Tuneable mechanical properties

Technology ID

2025-DOU-71158

Category

Chemicals & Advanced Materials/Polymer Science & Smart Materials

Chemicals & Advanced Materials/Green & Bio-Based Chemistry

GreenTech/Circular Economy & Waste Reduction

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Applications:

-Sustainable consumer goods

-Recyclable automotive parts

-Medical supplies

TRL: 4

Intellectual Property:

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Keywords: Recyclable rubber, sustainable rubber, bio-based muconate esters, PolyMEs, recyclable thermosets, vulcanization, depolymerization, monomer recovery, green rubber, circular economy