Environmentally Friendly Sustainable Thermoset Vitrimer-Containing Polyrotaxane for Circular Economy

Shota Ando[1*], Masaki Hirano[1], Lisa Watakabe[1], Hideaki Yokoyama[1], Kohzo Ito[1]
[1]*Grad. Sch. of Front. Sci., The University of Tokyo, Kashiwa, Japan*
[*]*s-ando@g.ecc.u-tokyo.ac.jp*

Durable green plastics with extended lifespans have self-healing properties and shape memoryandare chemically recyclable and marine biodegradable. These plastics are attracting attention inapplicationssuch as adhesives and carbon fiber composite materials. Vitrimers satisfy many of theserequirements, interms of reprocessability and self-healing. Herein, we report significant improvements in theproperties ofvitrimers induced by the ester-exchange reaction between polyester-grafted polyrotaxane (PR)and the esterbonds of epoxy resin vitrimer to achieve the uniform molecular dispersion of PR. The optimalepoxy resinvitrimer incorporated with PR (VPR) exhibited enhanced toughness, with an elongation at break 5.3times greater than that of a vitrimer devoid of PR; it also showed self-healing properties, was chemicallyrecycled 10times faster, and was recovered twice as fast. These results can be ascribed to the sliding diffusionmotion ofthe PR, which lowers the energy required for transesterification. Furthermore, VPR showed 25 wt%biodegradation following exposure to seawater for 30 days. These findings may lead to the developmentofenvironmentally friendly plastics that exhibit most of the properties required for a circular economy.

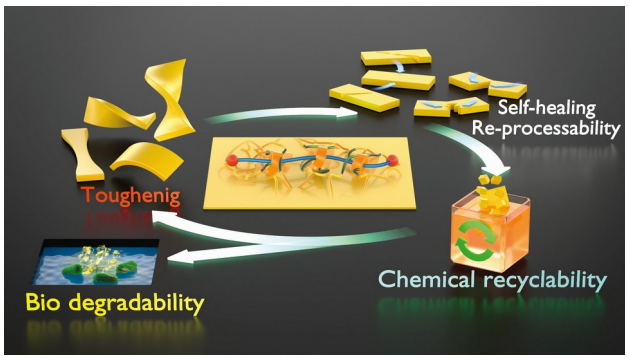

Figure. Vitrimer^containing poryrotaxane for circular economy.

Keywords: Polyrotaxane, Epoxy resin vitrimer, Dynamic covalent bond

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