Superhigh performance bioplastics having deformable rigid backbones

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Demand of high performance bio-based polymers has increased due to their excellent thermal, high chemical, good mechanical properties and environmental concerns. Conventional bio-based polymers have been derived from aliphatic polyesters and then the performances were very low and no remarkable functions were shown¹. On the other hand, bio-based aromatic polyimides or polyamides cover one of the most vital classes of high performance polymers to be suitable for using as super-engineering plastics. Nevertheless, an aromatic diamine as one of the monomers has never been derived from microbes due to their incompatibility with microorganisms²,³

Here we focused on bio-based super-engineering plastics of polyimides and polyamides derived from bioavailable aromatic diamines, which were photodimers of 4-aminocinnamic acid (4ACA) available from genetically-engineered Escherichia coli, and tetraacid. These polymers were processed into transparent films having high heat resistance ($T_g > 270$ °C, $T_{d10}$ : ca. 400 °C), owing to rigid backbones. Some of polyamides showed superhigh mechanical strength over 400 MPa keeping good transparency, and high strain energy density over 200 MJ/m³, based on the deformability of cyclobutanyl moiety. Low density was provided in the range of 1.18-1.38 g/cm³. Then the presence bio-plastics can hopefully contribute to the sustainable society establishment where high-performance and light-weight materials should be utilized.

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References
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