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Abstract of Doctoral Dissertation

Bio-based high performance polymers from 4-aminocinnamate photodimers

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The development of bio-based polymers is indispensable for the establishment of a sustainable low-carbon society. A number of aliphatic bio-based polymers such as polyesters and polyamides have been developed, but their low glass transition temperature, T_g, limited their use for various applications. From this point of view, a high mechanical strength and Young's modulus are also necessary. One of the most advanced classes of high-performance polymeric materials is the polyimides (PIs), with excellent thermo-mechanical performance, high chemical stability, etc. However, bio-derived PIs were very difficult to be prepared since the aromatic diamines cannot be made using biosynthesis because they are incompatible with microorganisms and plant cells. Not only the development of high-performance but also degradable bioplastics are significant for sustaining a low-carbon society. PIs generally show excellent durability but less environmentally degradability which may sometimes induce the negative effects on establishment of green-sustainable society. Hence, the degradability under specific condition is strongly requested. The PIs should potentially be applied as super-engineering plastics that are highly durable under useful lifetime but degradable after usages.

Here, we used the photodimer of a microorganism-derived aromatic monoamine, 4-aminocinnamic acid (4ACA), to prepare bio-derived PIs based on its reaction with various tetracarboxylic dianhydrides. The high performance PIs are high thermo-mechanical properties, high transparency, good cell-compatibility, and UV degradation.

Keywords: 4-aminocinnamic acid, photocycloaddition, bio-based polymer, high performance polyimide, UV degradation