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Project title: Developing Eco-Friendly Biocomposites with High Fiber Content through Green Modular Polymerization

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Abstract (approx. 200 words)**:**

Wood fibers are incredible reinforcement for biocomposites due to their renewable resource, wide availability, high mechanical properties, and low density. Producing high-reinforcement content biocomposites with degradable or chemically recyclable matrices is desirable for developing new materials. However, the development of high-fiber-content biocomposites is limited by the lack of proper processing methods that can provide adequate dispersion, no reinforcement damage, and compatibility. To address these challenges, we have considered in-situ polyester matrix formation within fiber networks. Polycaprolactone due to low melting temperature and degradability (hydrolyzablity) was a great candidate. The main synthetic route to polycaprolactone is the ring-opening polymerization of caprolactone. However, the challenge is that environmental moisture initiates polymerization, which significantly reduces the polymer's molecular weight. We employed a green in-situ polymerization strategy, utilizing condensation polymerization of functionally balanced caprolactone oligomers. This modular polymerization enabled us to create high-reinforcement content biocomposites with well-dispersed, mechanically undamaged fibers or nanocellulose fibrils. Thus, these biocomposites showed much higher mechanical properties than analogs in the literature. Reinforcement geometry (fibers or fibrils) influenced the polymerization and degradation behavior of the polyester matrix. This facile and scalable approach showed how to improve biocomposites' mechanical properties and sustainability in the context of a circular bioeconomy.

Key words:
Wood fiber, Nanocellulose, Biocomposite, Mechanical properties, In-situ modular polymerization, Chemical recycling, Poly(caprolactone)