Enhancing polyamide 6 Composites with chitin nanowhiskers: A sustainable approach to strength and performance improvement

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Synthetic polymers have maintained relevance across a multitude of emerging sectors due to their distinctive characteristics. However, concerns regarding their durability, sustainability, and mechanical properties have led to the development of filler-driven crosslinking to enhance the performance of the final materials. A key contemporary need lies in the automotive industry, which accounts for over 40% of the global nylon (PA 6) demand to replace metal components, aiming to reduce vehicle weight and improve fuel efficiency. For this reason, pure polymers are increasingly being substituted with composites made from base polymers reinforced with fillers.
However, many commonly used industrial fillers suffer from poor bonding with organic polymers, leading to suboptimal performance. This highlights the critical importance of exploring nanochitin as a key reinforcement agent in polymer composites. Chitin nanomaterials are biodegradable, biocompatible, lightweight, and possess a high elastic modulus with excellent specific stiffness—superior to metals, ceramics, or even Kevlar. Given the amide groups characteristic of nylons (PA 6), a strong interaction with nanochitin is anticipated.
In this study, we present the synthesis of polyamide nanocomposite films incorporating chitin nanowhiskers (ChNWs), derived directly from pure chitin using ionic liquids. Our objective is to investigate the structural (FTIR, pXRD), thermodynamic (TGA, DSC),

morphological (SEM), tensile, and rheological (DMA) properties of PA 6/ChNWs blends, prepared by casting and solvent evaporation. Specifically, we focus on evaluating the interfacial adhesion between chitin nanowhiskers and polymer chains, as influenced by varying ChNW content. Additionally, we explore whether the source of the chitin nanomaterials—extracted from different biomass sources—affects the reinforcement potential of the PA 6 films. Overall, our study highlights the unique functional properties of PA 6-based nanocomposite films, emphasizing their enhanced strength and potential to reduce the carbon footprint compared to traditional glass-reinforced plastics.

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