

Recovery of Nylon from Marine Waste for the Development of High-Performance Engineering Plastics

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해양 폐기물로부터 나일론 회수를 통한 고성능 엔지니어링 플라스틱 개발

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Abstract

Marine plastic waste has emerged as a critical global environmental challenge, with discarded fishing gear commonly referred to as “ghost nets” accounting for a significant proportion of oceanic plastic debris. Among these, waste fishing nets composed primarily of nylon (polyamide) are generated in large quantities annually due to intensive fishing activities and inadequate end-of-life management. These persistent materials pose severe ecological threats, including entanglement of marine organisms, disruption of aquatic ecosystems, and the generation of microplastics through long-term degradation processes. Consequently, the effective recycling and valorization of waste fishing nets have become increasingly important from both environmental and resource sustainability perspectives [1–3].

In this study, an integrated recycling strategy is proposed to recover nylon from marine waste fishing nets and convert it into high-performance engineering plastics. The process involves mechanical pretreatment, contaminant removal, and solvent-based or thermomechanical extraction techniques to obtain recycled nylon with high purity. The recovered nylon is subsequently modified and reinforced to overcome the typical deterioration in mechanical properties associated with recycled polymers. To enhance the mechanical and functional performance of the recycled nylon matrix, functional additives such as recycled carbon fiber reinforced polymer (rCFRP) and activated carbon are incorporated. The addition of rCFRP significantly improves tensile strength, stiffness, and impact resistance due to its high load-bearing capacity and interfacial reinforcement effects. Meanwhile, activated carbon contributes to enhanced thermal stability, adsorption capability, and potential environmental functionality. Through optimized compounding and processing conditions, a series of high-performance composite materials are successfully fabricated.

The developed materials exhibit substantially improved mechanical properties compared to pristine recycled nylon, demonstrating their potential as sustainable alternatives to conventional engineering plastics in structural and functional applications. This study not only provides an effective pathway for the valorization of marine waste but also contributes to the advancement of circular economy practices by transforming discarded fishing nets into high-value-added engineering materials.

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References

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