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Polyamide 6 recycled fishing nets modified with biochar fillers and reclaimed carbon fibers: an effort toward sustainability and circularity

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Purpose. The accumulation of plastics, including 640000 tons annually from discarded fishing gear (20 % of marine plastics), poses a severe threat to marine ecosystems. Circular economy strategies aim to address this issue by promoting the reuse and recycling of marine plastic waste.
Method. In this context, this study focuses on developing sustainable composites using recycled polyamide 6 (rPA6) from fishing nets, reinforced with biochar and recycled carbon fibers (rCF).
Results & Conclusions. In the first polymer composite, lignocellulosic biochar (5-15 wt.%) enhanced rPA6's mechanical properties and moisture resistance. The elastic modulus increased from 2.6 to 4.5 GPa, while water uptake decreased from 3.6 to 1.8 %. Additionally, rice husk-derived biochar, rich in silica, acted as a flame retardant by improving combustion resistance without significantly altering water uptake or mechanical behaviour [1]. The second polymer composite incorporated rCF produced through an innovative two-step thermo-oxidative process. This method enhanced rCF's compatibility with rPA6 by increasing surface activation (O/C weight ratio of 0.054 vs. 0.021 for virgin fibers) while preserving fiber dimensions (7-8 µm), mechanical strength (282 ± 35 vs. 293 ± 20 GPa), and surface smoothness (Figure 1). At 15 wt.% loading, rCF/rPA6 composites achieved a tensile modulus of 13.1 GPa and impact toughness of 28.4 kJ/m², compared to rPA6 alone (3.2 GPa and 11.8 kJ/m²) [2]. A Life Cycle Assessment (LCA) compared scenarios involving virgin materials and recycled components. The fully recycled scenario achieved a reduction of approximately 5.74×10^3 kg of CO_2 equivalents, demonstrating significant emission savings despite slight increases associated with wastewater treatment.

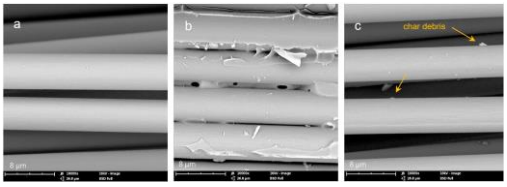

Figure 1. SEM images of vCF (**a**), rCF after pyrolysis (**b**) and rCF after pyrolysis and gasification (**c**).

References

[1] D. Rossi, *Materials Today Communications*, **2024**, *41*, 110650. [2] F. Pasciucco, *Journal of Cleaner Production,* **2025**, *486*, 144634.

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