Enhancing the Recyclability of Polycarbonate Using Graphene Nanoplatelets

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The growing reliance on polymers has intensified concerns about their persistence in the environment and the difficulties associated with their recycling. Thermoplastics, in particular, have gained widespread adoption since World War II due to their light weight, versatility, and ease of processing, replacing metals in applications from packaging to automotive parts [1]. Yet, unlike metals, only a small fraction—around 10%—of thermoplastics are effectively recycled, as repeated processing causes polymer chain degradation, leading to diminished mechanical performance and restricted reuse [2].

In this work, we examine the reinforcement of polycarbonate (PC) with graphene nanoplatelets (GNPs) as a strategy to enhance both recyclability and mechanical durability. Our findings show that unmodified PC becomes unsuitable for reuse after approximately three recycling cycles, primarily due to reduced molecular weight and loss of tensile strength. When GNPs are incorporated, however, the recyclability of PC is extended, with tensile strength and molecular weight maintained across multiple cycles. These results suggest that GNP addition is a promising route for mitigating recycling-induced property loss in thermoplastics, offering a pathway toward more sustainable material use.

References

[1] Kazemi M, Faisal Kabir S, Fini EH. State of the art in recycling waste thermoplastics and thermosets and their applications in construction. Resour Conserv Recycl 2021;174:105776. https://doi.org/10.1016/j.resconrec.2021.105776.
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Figures

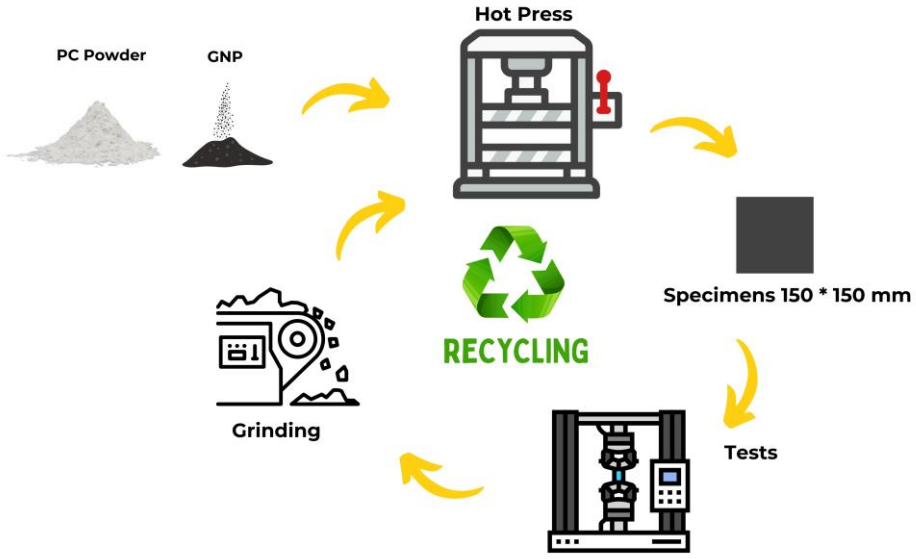

Figure 1: Recycling process for polycarbonate