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Fiber-Induced Crystallization of Recycled Polypropylene

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Introduction

Repeated mechanical recycling can degrade polypropylene (PP), reducing its mechanical performance. PP fiber reinforcement offers a promising strategy to restore mechanical properties while promoting transcrystalline layer (TCL) formation at the fiber–matrix interface, potentially improving interfacial adhesion and stress transfer[1].

Objectives

This study aims to improve the mechanical performance and crystalline structure of recycled PP composites through PP fiber reinforcement and interfacial crystallization. Specifically, the effects of PP fiber content, recycled/virgin PP blending, and MAPP modification on tensile and flexural properties were investigated. DSC, XRD, and POM analyses were conducted to examine crystallization behavior, with particular emphasis on TCL formation around PP fibers and its relationship with mechanical reinforcement.

Methodology

Recycled PP was prepared through six extrusion cycles and blended with virgin PP (30:70). MAPP, PP short fibers (10–40 wt%), and pine cone powder (PCP, 15 wt% for selected formulations) were incorporated through extrusion and injection molding. Mechanical properties and interfacial crystallization were evaluated using tensile/flexural tests, DSC, XRD, POM, and SEM.

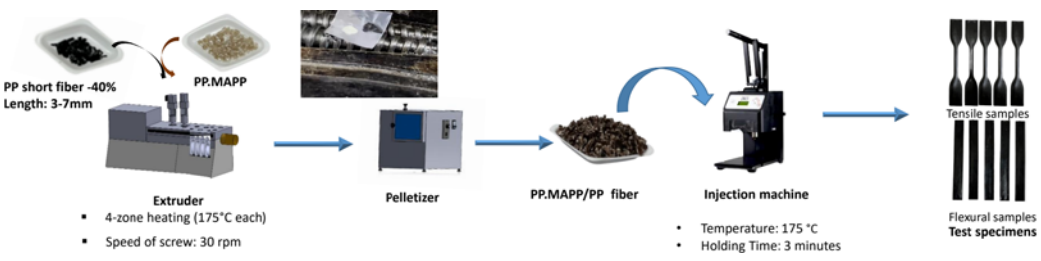


Figure 1. Schematic illustration of the manufacturing process for PP fiber-reinforced composites.

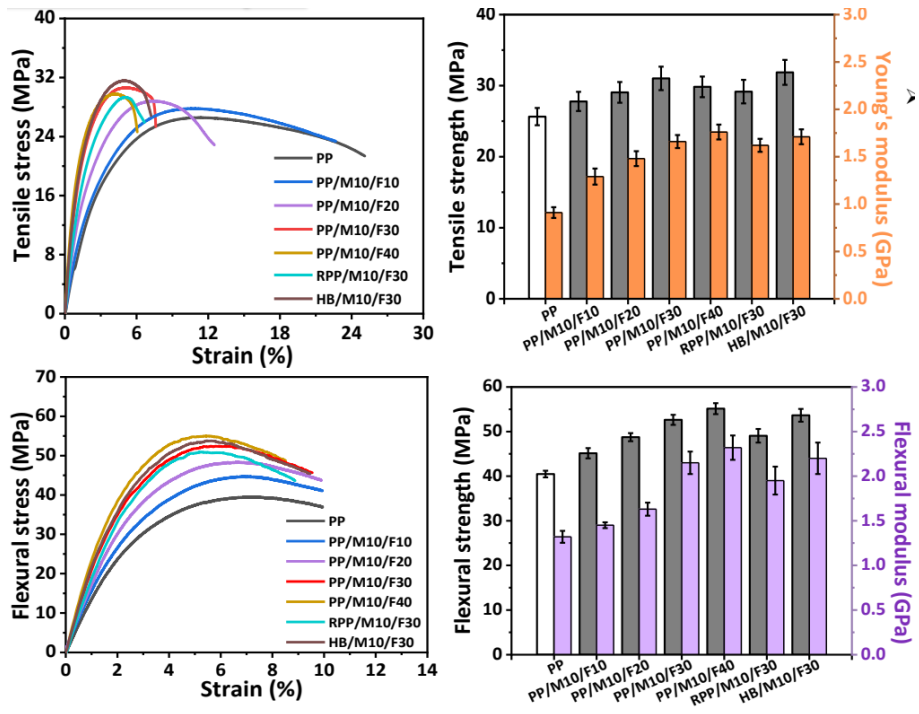


Figure 2. Tensile and flexural properties of PP fiber-reinforced composites with varying fiber contents

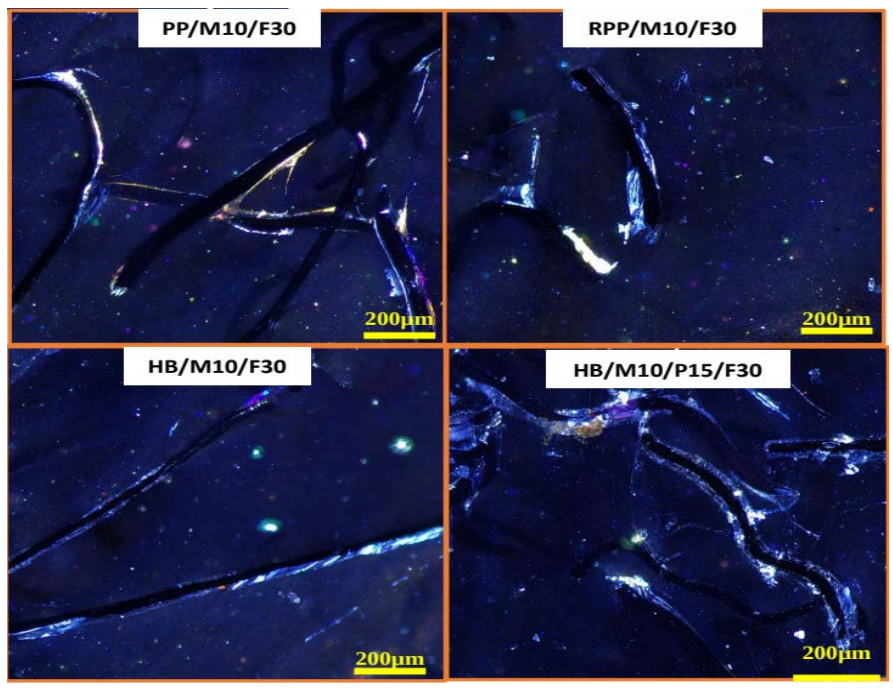


Figure 3. Polarized optical microscopy images showing transcrystalline layer formation around PP fibers in different PP matrices

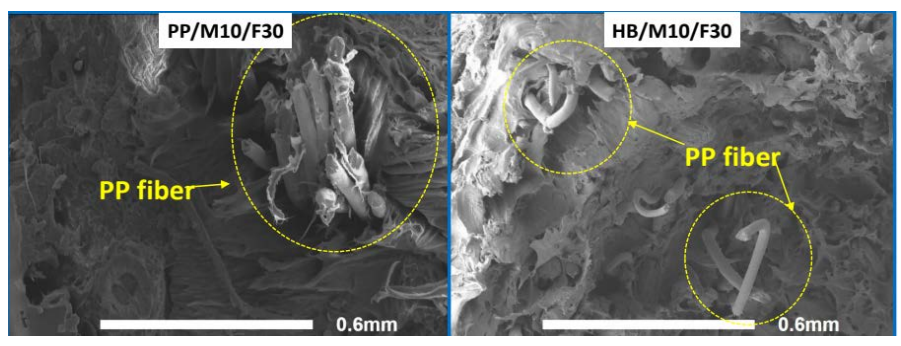


Figure 4. SEM images of fracture surfaces showing PP fiber distribution and matrix morphology

Results and Discussion

- **Mechanical performance:** PP fiber reinforcement improved tensile and flexural properties, with 30 wt% providing a favorable overall balance.
- **Transcrystallization:** POM revealed crystalline layers around PP fibers, supporting fiber-induced interfacial crystallization.
- **Interfacial morphology**: SEM revealed differences in fiber distribution and fracture surface characteristics among the composite formulations.

Conclusions

PP fiber reinforcement enhanced the mechanical performance of recycled PP composites, with 30 wt% fibers providing balanced tensile and flexural properties. POM observations revealed transcrystalline layer formation around PP fibers, while SEM analysis highlighted differences in interfacial morphology. These findings demonstrate the potential of fiber-induced crystallization for improving recycled PP composites.

References & Acknowledgements

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