Properties of carbon fiber-reinforced lightweight polyamide composites produced by in situ polymerization

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Cross-linked matrix polymer composites are widely used structural materials in various industries (e.g., aerospace, wind energy, and sports equipment). However, a significant drawback is their limited recyclability and the complexity of repair processes, which require challenging and labor-intensive procedures. Thermoplastic matrix composites offer a potential solution to these challenges. In addition to traditional short- and long-fiber injection molding, a novel technique called T-RTM (Thermoplastic Resin Transfer Moulding) has emerged in recent years. This method utilizes the anionic ring-opening polymerization of caprolactam to produce continuous fiber-reinforced composites with a polyamide 6 (PA6) matrix. This technological combination can create new possibilities for developing innovative, functionally integrated composites that were previously unachievable or required cross-linked matrix materials [1, 2].

The use of thermoplastic matrix materials is highly beneficial, as composites made with them align well with the principles of the circular economy. Their easy repairability extends their lifespan, while their thermoplastic matrix ensures straightforward recyclability, substantially reducing environmental impact. Although this research area is relatively new, numerous research groups have already started exploring it [3].

In our study, we investigated the polymerization process of caprolactam and produced carbon fabric-reinforced composites using the T-RTM method. First, we analyzed the effects of manufacturing conditions (e.g., mold temperature, polymerization time) on the properties of the resulting PA6. Based on the optimal parameters, we produced carbon fabric-reinforced polyamide composite plates with different layer configurations. Finally, we evaluated the impregnation efficiency and the mechanical properties of the composites.

References

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