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Hybridization effect on interlaminar bond strength, flexural properties, and hardness of carbon–flax fiber thermoplastic bio-composites

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Abstract-

Hybridizing carbon-fiber-reinforced polymers with natural fibers could be a solution to prevent delamination and improve the out-of-plane properties of laminated composites. Delamination is one of the initial damage modes in composite laminates, attributed to relatively poor interlaminar mechanical properties, e.g., low interlaminar strength and fracture toughness. This study examined the interlaminar bond strength, flexural properties, and hardness of carbon/flax/polyamide hybrid bio-composites using peel adhesion, three-point bending, and macro-hardness tests, respectively. In this regard, interlayer hybrid laminates were produced with a sandwich fiber hybrid mode, using woven carbon fiber plies (C) as the outer layers and woven flax fiber plies (F) as the inner ones (CFFC) in combination with a bio-based thermoplastic polyamide 11 matrix. In addition, non-hybrid carbon and flax fiber composites with the same matrix were produced as reference laminates to investigate the hybridization effects. The results revealed the advantages of hybridization in terms of flexural properties, including a 212% higher modulus and a 265% higher strength compared to pure flax composites and a 34% higher failure strain compared to pure carbon composites. Additionally, the hybrid composites exhibited a positive hybridization effect in terms of peeling strength, demonstrating a 27% improvement compared to the pure carbon composites. These results provide valuable insights into the mechanical performance of woven carbon–flax hybrid bio-composites, suggesting potential applications in the automotive and construction industries.

Index Terms- hybrid thermoplastic bio-composite; flax fibers; PA11; interlaminar bond strength; hardness; flexural properties

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