Mechanical Characterization of Forged Carbon Fiber Composites for Advanced Aviation Components

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Abstract: This study investigates Forged Carbon technology—a compression molding process using chopped carbon fibers—as a high-performance alternative to traditional continuous fiber laminates and aerospace metals. While continuous fiber composites offer superior strength, they are often limited by high production costs and geometric constraints. The research evaluates the tensile properties of forged carbon, focusing on the influence of fiber length (6 mm and 15 mm) on mechanical parameters, including maximum stress, strain, and Young's modulus.

The methodology involved testing 43 samples fabricated with high-grade epoxy resin using a dedicated compression mold. Static tensile tests and failure mode analyses (macroscopic and microscopic) were conducted to assess fiber distribution and resin impregnation. Results show that fiber length significantly impacts load-bearing characteristics, while the material achieves a high degree of isotropy in the X-Y plane, which is beneficial for complex components under multi-directional loading.

Although absolute tensile strength is lower than in unidirectional laminates, the specific strength (strength-to-weight ratio) remains highly competitive against traditional aluminum and titanium alloys. Failure analysis indicated that fracture primarily occurred through fiber pull-out and matrix cracking. The study confirms forged carbon as a viable technology for non-primary aircraft structures, offering an optimal balance between weight reduction, production scalability, and geometric versatility for advanced aerospace applications.