

Study of Mechanical Characteristics of Modified Polymer-Based Composite Materials under Ultra-Low Temperatures

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Abstract

Investigations of the mechanical properties of the modified polymer-based composite materials under ultra-low temperatures, addressing a critical gap in material performance for cryogenic applications, are presented in this study. The study focuses on analysing of the key mechanical properties (such as tensile strength, impact resistance, and fracture toughness) of fiber-reinforced polymer composites at temperatures ranging from -30°C to 0°C . Experimental results obtained showed the significant variations in brittleness, stiffness, and crack propagation characteristics compared to room-temperature results, however certain composition demonstrated enhanced low-temperature ductility. The obtained results indicate that optimized modifier compositions can reduce typical low-temperature embrittlement, achieving up to 30% improvement in impact resistance while maintaining structural integrity. The results are valuable base for developing durable polymer composites suitable for application in aerospace, polar engineering, and energy storage systems operating in extreme cold environments. The research is significant to the fundamental understanding of polymeric materials behavior at cryogenic conditions. Proposals of practical strategies for formulating high-performance composites for cryogenic applications have been developed.