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Multifunctional epoxy/carbon fiber laminates for thermal energy storage and release

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Abstract

This work is focused on the preparation and characterization of novel multifunctional structural composites with thermal energy storage (TES) capability. Structural laminates were obtained by combining an epoxy resin, a paraffinic phase change material (PCM) stabilized with carbon nanotubes (CNTs), and reinforcing carbon fibers. The stabilized paraffin kept its ability to melt and crystallize in the laminates, and the melting enthalpy of the composites was proportional to the paraffin weight fraction with a maximum value of 47.4 J/cm^3. This thermal response was preserved even after fifty consecutive heating-cooling cycles. Moreover, the thermal conductivity of the laminates through thickness direction resulted to increase proportionally to the content of CNT-stabilized PCM. The capability of the developed TES laminates to contribute to the thermal energy management was also proven by monitoring their cooling rates through thermal imaging. The flexural modulus was only slightly affected by the presence of the PCM, while a decrease of flexural strength, strain at break and interlaminar shear strength was detected. Optical microscopy highlighted that this could be attributed to the preferential location of the PCM in the interlaminar region. The obtained results demonstrated the feasibility of the concept of multifunctional structural TES composites.

Keywords: functional composites; thermal properties; polymer-matrix composites (PMCs); carbon nanotubes; carbon fibers.