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Characterization of low-velocity impact-induced damages in carbon/epoxy composite laminates using a poly(vinylidene fluoride–trifluoroethylene) film sensor

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ABSTRACT

In this work, low-velocity impact-induced damages such as matrix cracking and delamination in composite laminates made of unidirectional carbon fiber/epoxy and woven carbon prepregs with different stacking sequences were investigated by using a poly(vinylidene fluoride–trifluoroethylene) (P(VDF-TrFE)) film sensor. The effect of insertion of film sensor having various areal ratios on the structural integrity of the host composite was investigated by conducting tensile and short beam shear tests. The findings revealed that the degradation rates of the Young's modulus, strength, and inter-laminar shear strength were in the acceptable range; the degradation rate was 7–8% even under unrealistically harsh conditions. Subsequently, low-velocity impact tests were performed by using a drop-weight impact machine (11.77–28.25 J). For damage characterization of the composite laminates, four P(VDF-TrFE) film sensors were inserted at different sites in each composite laminate at the impact point. By considering the relationships between impact energy, voltage output from the sensors, and the corresponding material failure modes, an estimation technique for the potential failure of the composite laminates that experienced low-velocity impacts was suggested.

Keywords: A. Polymer-matrix composites (PMCs); A. Laminates; A. Smart materials; B. Impact behavior; D. Mechanical testing.