Enhancing damping for composites aerospace structures with piezoelectric and carbon nanoparticles

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Organic Matrix Composites are more and more frequently used in the conception of new aerospace structures rather than metallic solutions. Composite materials have among other characteristics, the advantageous relation between rigidity and weight ratio. However, a major drawback is the decrease of damping ability and the increase of vibration levels. Recent R&D activities targeted promising concepts based on materials filled with dissipative particles [1-2]. For aerospace structures, payload comfort and structures reliability needs enhanced vibration and dynamical responses: Adding a new contribution - the local transduction-dissipation - within composites structures for enhancing energy dissipation is the main goal of this research.

In this context we investigated the promising ability for dissipating mechanical energy of composite structures by using damping layers containing piezoelectric fillers and electrically conductive particles. The main idea was to adapt a macroscopic resistive-piezoelectric shunt to the material scale. The introduction of this embedded passive damping material could be a solution with significant weight and cost reductions.

Preliminary materials characterization was needed to identify the dissipative behavior. Experimental analysis carried on laboratory scaled beams highlighted the strong non-linear effects on the frequency and amplitude dependency in the strain-stress relation, where the hysteresis cycle has been identified via Dynamic Mechanical Analysis tests. Vibrations tests were performed for several excitation amplitudes in a sweep of a large frequency range with composite sandwich beams prepared at laboratory scale. Dynamical response was followed later for dissipative material embedded in representative aerospace carbon-fiber aluminum-honeycomb sandwich panels with different payloads configurations. Non-linear effects and dissipative performances up to 50 % were pointed out for the different structures. Results brings promising dissipative behavior for aerospace applications.

REFERENCES

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