New Enhanced Acoustic Damping Composite Material for the Aeronautics Industry

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ABSTRACT

The aim of the present study is to investigate a structural composite material concept with the additional functionality of acoustic damping. To this end, a standard modulus Carbon Fiber Reinforced Plastic (CFRP) prepreg is used as the baseline material. The damping performance of this substrate prepreg is enhanced by the addition of an elastomeric layer, which becomes embedded in the composite structure when formed. The elastomeric layer, which is designed to co-cure with the thermoset prepreg, acts as part of a constrained layer damping (CLD) system. This confers acoustic attenuation performance on the cured laminate.

The target application of the study is the fuselage skin. The existing solution requires the manual addition of heavyweight, bespoke damping elements that are applied following part production and assembly. Such an approach adds inventory, time, weight and, ultimately, cost. The main drivers for the exploration of this technology are the potential for weight saving, maintaining or increasing production rate and the associated benefits in cost saving. These are all key targets in the commercial aerospace sector. Weight savings and cost reductions are delivered in part by the embedded nature of the damping solution. The modified prepreg can be processed using established manufacturing techniques such as Automated Fibre Placement (AFP) or Automated Tape Laying (ATL). This allows for high production rates.

Acoustic performance was assessed within the range -55°C to 70°C using a modified Oberst beam test, selecting the most appropriate resonance modes for measurement. Damping was quantified using a half-power bandwidth method. A range of elastomers and composite structures were screened.

With regard to structural performance, it would be desirable to maintain substantially the same level of performance as the reference CFRP. However, it is recognised that a decrease in mechanical performance may be tolerable if a substantial weight saving can be achieved and additional measures may then be taken to recover performance. By definition, the introduction of a rubbery layer within a laminate has a detrimental effect on its mechanical performance. A mechanical test campaign has been performed in order to quantify the structural behaviour of the multifunctional solution proposed.

It has been demonstrated that damping effectiveness is related to the relative amount of shear stress in the x-y plane, best performance being associated with the positioning of the damping element at the location of maximum shear during bending. Placing the damping element centrally within the simple test specimen of this study was found optimal from a damping perspective, but then delivered the poorest mechanical performance. Strategies to mitigate this contradiction were explored.

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