Impact Fatigue Performance of Adhesive Bonded Structures Based on GRIP Metal™ Concept

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ABSTRACT

GRIP Metal™, a commercially available sheet metal product with extruded hooks, offers the potential to enhance interlaminar strength of Fiber Metal Laminates (FML) by providing mechanical fastening between the composite laminate and the aluminum sheet. However, the fatigue performance of such a joint is of concern due to the interaction between the hooks, and fibers. The purpose of this work is to evaluate the effects of GRIP Metal™ on the fatigue performance of a bonded joint using a new impact fatigue test method. Circular samples with a lap joint are fabricated by bonding two sheets of Al2024-T3 with epoxy impregnated glass fiber in between. These samples are stressed through repeated impact, for up to 600,000 cycles, to evaluate the onset of delamination and development of cracks. In addition, the effects of surface preparation including degreasing using Methyl Ethyl Ketone only, Sol-Gel AC-130 (an adhesion promoting coating), and coating with a release agent are also studied. During impact fatigue testing, samples are inspected regularly for delamination and crack formation using an optical microscope, as well as a Scanning Electron Microscope (SEM). It was observed that samples with GRIP Metal™ contained imperfections such as cracking and delamination after approximately 140,000 cycles. It was also found that after approximately 600,000 cycles almost all samples without GRIP Metal™ had failed (complete separation of bonded structure), including those treated with surface degreasing only and most of those treated with Sol-Gel surface treatment. GRIP Metal™ samples of any hook geometry or surface treatment showed the most promising results, i.e., after 600,000 impact fatigue cycles, no separation was observed.