Abstract

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Acoustic Emission Testing of Composite-to-Metal and Metal-to-Metal Adhesive Bond Strengths

Composite sandwich structures consisting of two layers with an adhesive contacting interface are of importance in a number of industrial applications such as aerospace, marine and automotive. This research therefore aims to characterise the failure behaviour of adhesively bonded specimen (e.g. carbon fibre reinforced composite-to-metal adhesive bonded substrates) and failure modes namely Mode I: double cantilever beam (DCB) and Mode II: three-point end notch flexures (3-ENF) using the acoustic emission (AE) monitoring technique. AE may aid in the understanding of the mechanics behind the specified failure modes of adhesively joined composite structures. In order to control the adhesively bonded area, a dry anti-stick film was applied to the mating surfaces, which can simulate a bonding quality. Twelve adhesively bonded specimens, for each failure mode, were prepared using two types of adhesive bond materials (acrylic-based ductile bond and cyanoacrylate-based brittle bond) with three variations of adhesive bond quality. Prior to mechanical testing, the adhesive bonded specimens were examined using AE to obtain understanding of signal transmission within the structure. It was possible for the maximum AE amplitude method to Select the AE events of mechanical significance (e.g. adhesive failure, substrate deformation) for further identification through thorough analysis. From this maximum AE amplitude method, it was possible to distinguish between the different AE sources of mechanical significance. However, it was proved difficult to propose a definitive AE trait for the mechanical phenomena occurring within specific AE event signals, for all adhesive types, bond qualities, and substrate configurations therefore all specimen combinations. There was a notable shift in spectral energy proportion as the AE source of mechanical significance varied along the specimen length for particular specimen combinations. However, it was difficult to confirm this distinctive trait for all specimen combinations due to difficulty in confirming the location and exact mechanical source. However, the proposed measurement technique can be useful to assess the overall structural health of a bonded system (e.g. pipe-in-pipe) and may allow identification of defects that can significantly reduce the strength and reliability of material, consequently increasing the risk of component failure.