KISSING BOND ASSESSMENT IN ADHESIVE BONDED CARBON FIBER REINFORCED COMPOSITES USING DIELECTRIC SPECTROSCOPY

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10:00 AM, Monday, August 5th, 2024

Wolf Hall, Room 413

Abstract

The widespread use of fiber-reinforced composites in industries such as space, aviation, automobiles, and construction necessitates the formation of robust composite joints between critical structural components. Although adhesive-bonded joints are superior with improved load distribution and reduced weight, they are often overlooked in favor of bolted joints and mechanical fasteners due to the lack of reliable Non-Destructive Evaluation (NDE) techniques for adhesive-bonded composites. The anisotropic nature of the substrate and the intricate interfacial interactions between the adherend and adhesive material present significant challenges for conventional NDE methods. Moreover, weak adhesive bonds can result from uncontrolled manufacturing parameters, such as accidental contamination from mold release agents, grease, improper contact between the adherend and adhesive, or inadequate adhesive curing. If the strength of these weak adhesive bonds falls at or below 20% of the expected strength of a strong bond, they are referred to as ‘Kissing Bonds’. Identifying and eliminating these bonds in service is crucial to prevent catastrophic joint failures. Frequency domain dielectric spectroscopy has been used to characterize adhesive-bonded carbon fiber composite joints. Using Broadband Dielectric Spectroscopy (BbDS), consistent correlations between the dielectric variables at 0.1Hz and 0.1MHz and adhesive bond performance for a given material system have been observed, thus identifying kissing bonds. The collected surface, dielectric, and bond variables were used to predict kissing bond formation using machine-learning classification models. The observed correlations were also used to model kissing bond formation using interfacial electrical properties.