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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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DETECTION AND LOCALIZATION OF DEBONDING IN SANDWICHED ALUMINUM HONEYCOMB COMPOSITES WITH ULTRASONIC GUIDED WAVES

Abstract

Sandwiched composites with honeycomb cores have been used in the aerospace community since 1915. These composites offer a lightweight alternative to other, more traditional materials, without loss of strength. Over time, they have been employed across a wide range of applications, from snowboards and boat hulls to modern aircraft fuselages and rocket motor casings. Launch vehicles such as the STS Orbiter and Atlas V, as well as spacecraft, such as the Mars Exploration Rover and Hubble Telescope, rely on the high flexural rigidity of sandwich composites for their structural integrity, which can be compromised if the face sheet becomes debonded from the sandwiched honeycomb. In response to this risk and the relative lack of composites operating experience within NASA, current NASA structural standards are extremely conservative, driving potentially unnecessary increases in weight. As such, there is significant interest in reliable methods to detect and localize face sheet debonding from either side of the material, which could significantly reduce the required safety factors. Ultrasonic guided waves offer a promising tool to quickly interrogate large, plate-like structures, including inaccessible areas. Since guided waves propagate through the entire thickness of the structure, they are capable of detecting features, such as debonding, on either side of the structure. In situ sparse arrays of lightweight, inexpensive piezoelectric transducers have already demonstrated an ability to leverage guided waves for detection of defects, such as delaminations, in layered composite panels and may be capable of performing comparable detection in sandwiched honeycomb composites. The complex internal geometric structure of these composites, however, is expected to cause significant scattering artifacts that present a unique challenge for damage detection and localization algorithms, particularly for a sparse array, which uses a limited number of sensors. This work investigates the feasibility of employing a sparse array of ultrasonic transducers to detect and locate simulated debonding in an aluminum honeycomb panel. Wavefield imaging is used to investigate the excitability of the fundamental guided wave modes, their attenuation, dispersive properties, and sensitivity to simulated debonding. This information is then applied to the optimization of a sparse array of piezoelectric transducers for detection of debonding in sandwiched aluminum honeycomb composites.