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Paper Session II-A - Mixed-Mode Interfacial Fracture Toughness of Sandwich Composites at Cryogenic Temperatures

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Mixed-Mode Interfacial Fracture Toughness of Sandwich Composites at Cryogenic Temperatures

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Abstract for the 41st Space Congress

Honeycomb sandwich composites are found in a wide range of structural applications due to their high strength and stiffness-to-weight ratio compared to other systems. Current use of sandwich composites ranges from secondary structures in commercial aircrafts to primary structures in military aircraft, helicopters, and reusable launch vehicles, e.g. Space Shuttle. One of the applications of sandwich construction is in the liquid hydrogen tank of future RLV's. Because of their low density and high stiffness sandwich construction is attractive for LH2 tank. However, past tests shave shown that leakage of hydrogen through the composite face sheet and subsequent debonding of the face-sheet is a major concern in using sandwich construction. This problem can be eliminated by thorough understanding of the fracture mechanics of face sheets under cryogenic conditions.

This study aimed to understand the failure phenomena of sandwich composites constructed from carbon fiber/epoxy composite face sheets and Nomex honeycomb cores. Both experiments including testing under cryogenic conditions and finite element analyses are performed to understand the conditions under which debonding occurs and propagates. One of the major objectives of the study is to measure the critical energy release rate or fracture toughness of the face-sheet/core interface, which will be a strong function of mode-mixity and temperature. Furthermore, mode-mixity itself will depend up on the geometric factors such as crack length, face sheet and core thickness, and material stiffness parameters.

Fracture tests similar to double cantilever beams will be performed on sandwich panels containing initial delaminations. The fracture toughness will be measured for various crack lengths. The loads at which crack propagation occurs will be applied in the finite element model of the panel to obtain the detailed stress field in the vicinity of the crack tip.

From the results of the fracture tests and finite element analysis the interfacial fracture toughness of the sandwich panel under cryogenic conditions can be measured. Application of the results to the design of a LH_2 tank will be demonstrated.