Paper ID: 49520
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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SLS PRODUCTION FRICTION STIR PLUGS BY SOLID STATE ADDITIVE DEPOSITION

Abstract

The current Friction Pull Plug Welding (FPPW) process for closing holes caused by Friction Stir Welding (FSW) is presenting a mission-critical engineering problem for the production of the Space Launch System (SLS) vehicle for NASA. In FPPW, a conical piece of aluminum is simultaneously spun and plunged into the existing machined hole, resulting in an assembly of parent material and plug. Typically, failure occurs because of delamination at this interface due to a lack of metallurgical bonding and severe anisotropy in the material microstructure. The solid state additive friction stir MELD technology has the capability to alter the current FPPW method currently utilized by the EM32 Advance Weld Processes Development Laboratory at NASA MSFC. The MELD process can tailor microstructures as a function of transverse and rotational tools speed to ensure optimal material properties. Thus, MELD 2219 material has the potential to produce higher plug reliability than the metal currently being used to close FSW holes.

This work characterizes the effect of the MELD process of AA2219-T87. Specifically, it presents ideal process parameters for the MELD process and determines the "goodness" of the MELD 2219 plug as characterized by cyclic plastic response, monotonic tensile response, microhardness, grain size, and -phase size, distribution, and volume fraction. Additionally, an existing finite element based deformation model designed to capture kinematic and isotropic hardening/softening throughout the life of MELD 2219 is calibrated. Ultimately, a foundation is created upon which future research can be used to create a physics-based model to optimize the MELD process for SLS implementation.