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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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WELDING UNDER MICROGRAVITY CONDITIONS: EXPERIMENTAL RATIONALE, BACKGROUND, AND APPROACH BY THE UNIVERSIDAD CENTRAL DE VENEZUELA TEAM, AWARDEE OF THE 2024 DROPTES

Abstract

The rapid evolution of the space sector and the increasing involvement of governments and private companies in the space arena require new technologies and innovations to strengthen and grow a robust space economy. As part of the push for this new space economy, complex and large structures will be required in low orbit, on the lunar surface and beyond. Therefore, assembly and construction in vacuum and microgravity conditions, as well as the development of novel inspection techniques, will play a critical role in space exploration by opening up new possibilities, reducing costs, and overall making the future of the space economy sustainable. In this sense, one of the manufacturing processes that can play a significant role in achieving these goals is welding. Welding has the potential to completely transform the manufacturing, assembly, and design of orbital and lunar platforms by enabling the construction of infrastructure without mechanical joints, in-situ repairs, and the reuse of spare materials, thereby reducing costs and mission expenditures. However, little research has been done on welding in lunar or space environments. For this reason, the Universidad Central de Venezuela team applied to the 9th round of the Drop Tower Experiment Series (DropTES) grant program to propose an experiment to study the effects of microgravity on the microstructural behavior of aluminum welds. In this regard, the research will seek to: characterize the metallography, grain size, microstructural properties, and heat-affected zone (HAZ) of microgravity welds; compare the metallography, grain size, microstructural properties, and HAZ of microgravity welds with known terrestrial weld patterns; compare the characteristics and length of the HAZ with and without a heat exchanger; study the behavior of the weld pool under microgravity conditions; characterize the behavior and settings of the TIG welding process under microgravity conditions; and study the utility of the infrared thermography NDT technique as an NDT technique for real-time inspection of an aluminum alloy welded joint under microgravity conditions.