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NASA ADDITIVE MANUFACTURING INITIATIVES: IN SPACE MANUFACTURING AND ROCKET ENGINES

Abstract

There are two focal areas of the presentation: In Space Manufacturing (ISM) and additive manufacturing (AM) for liquid rocket engine development. In Space Manufacturing has been described as an "essential technology for deep space exploration." The initial step in the development of this capability has been taken by NASA's Marshall Space Flight Center (MSFC), in partnership with Made In Space, by successful completion of the first technology demonstration of 3D printing on the International Space Station (ISS). A summary of the initial results and comparison to the Phase 2 materials characterization results will be presented. An overview of the results of the quantitative benefits analysis for utilization of ISM on deep space exploration missions conducted by the Evolvable Mars Campaign team will be presented. Plans for future additive manufacturing (AM) efforts on ISS will be described. In addition, progress in other elements of NASA's In Space Manufacturing initiative, specifically, material characterization for the second generation printer, Additive Manufacturing Facility; in-space Recycler ISS Technology Demonstration development; launch packaging recycling; in-space printable electronics; component verification and validation approach; and Additive Construction by Mobile Emplacement (ACME) will also be addressed.

Additive Manufacturing (AM) stands ready to revolutionize much of the aerospace design and manufacturing paradigm. The process of building parts incrementally enables new designs, reduces costs, and provides flexibility previously impossible in the typical engine hardware development cycle. The NASA Marshall Space Flight Center is actively demonstrating lean engine development utilizing additive manufacturing to prototype engines for lander and in-space propulsion applications. MSFC has successfully test-fired a liquid-fueled breadboard engine in which 75

Given the strengths of additive manufacturing, the spaceflight industry is motivated to incorporate AM hardware in safety-critical structural applications. To safeguard against loss of mission and loss of life, the safe implementation of additive manufacturing, a new and rapidly changing technology, is vitally important. To ensure the reliability of additively manufactured hardware, MSFC spearheaded the development of quality standards that present methodology for the design and production of additively manufactured spaceflight hardware. In 2015, the draft standard was released to the broader aerospace community for evaluation and review, resulting in over 1000 comments. The updated standard is expected to be released in the spring of 2017. The key elements of this standard will be discussed.