

# **Large Scale and Multi-Alloy Rocket Engine Component Development using Various Metal Additive Manufacturing Techniques**

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The NASA Marshall Space Flight Center (MSFC) has been involved with various forms of metallic additive manufacturing (AM) for use in liquid rocket engine component design, development, and testing since 2010. These AM techniques have been demonstrated to significantly reduce hardware cost, shorten fabrication schedules, increase reliability by reducing the number of joints, and improve hardware performance by allowing fabrication of designs not feasible by conventional means. The focus at the NASA MSFC for these metal additive manufacturing techniques include laser powder-bed fusion (L-PBF), blown powder directed energy deposition (DED), arc-based deposition, and Laser Wire Direct Closeout (LWDC). A variety of components have been evaluated and tested including thrust chamber injectors, injector components such as faceplates, regeneratively-cooled combustion chambers, regeneratively-cooled nozzles, gas generator and preburner hardware, and augmented spark igniters. To support these component applications in harsh environments, NASA has advanced a variety of “standard” additive manufacturing alloys such as those in the superalloy-family and also evolved new alloys including GRCo-84, GRCo-42, NASA HR-1, and JBK-75. The purpose of this presentation is to discuss the various component programs at the NASA MSFC using AM to develop, fabricate, and test combustion devices hardware and the evolution of the new additive alloys. One of these projects that will be highlighted is Rapid Analysis and Manufacturing Propulsion Technology (RAMPT), which includes new process development for large scale AM components, multi-metallic AM components, including unique component designs using additive manufacturing. Additional information will be provided on the development of other components, hot-fire testing, post-processing of AM techniques including surface enhancements (polishing) techniques, material and process characterization, future development programs, and dissemination of data to industry partners.