Characterizing Performance of Additively Manufacturing Regenerative Cooled Combustion Chambers through Hot Fire Testing

C. P. Garcia, P. Gradl, J. Wood, C. S. Protz, and S. E. Greene

NASA Marshall Space Flight Center (MSFC) has developed several additive manufactured regenerative cooled combustion chambers from 2014 to present. Chambers have been constructed using the Selective Laser Melting (SLM) powder bed additive manufacturing (AM) technique. The materials used for the chambers has varied from Inconel 718, Inconel 625, GRCop-84, and C18150 metal alloys. The surface finish and build techniques used to successfully manufacture combustion chambers using the SLM AM result in as built surface finish and off nominal geometric features. This paper discusses and reviews the effects of surface roughness, flow area, and hydraulic performance of regenerative cooled combustion chambers. The thrust chambers designs tested ranged from 200 to 1,400 psia producing 1,000 to 35,000 lbf thrust. Empirical data from four test campaigns will be reviewed and related to design modeling parameters such as pressure drop, surface roughness, and actual fluid flow geometry. Correlation results with simple 2-D CFD modeling will also be presented. The goal of the work is to better understand how the finished additive manufactured component characteristics inside internal features can effect regenerative cooling chamber design. Adjustments to design methodology will be discussed and recommended based on the above results.