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APPLICATIONS FOR 3D PRINTING IN THE DESIGN OF HALL EFFECT THRUSTERS

Abstract

Maturation of Direct Metal Laser Sintering (DMLS), binder jetting, and other additive manufacturing technologies has spurred an interest in the 3D printing of components for chemical rocket engines. The complex injector geometries and feed systems found in chemical rockets are costly to manufacture using subtractive methods, and reductions in weight and part count can be achieved through the use of 3D printing. Less consideration has been given to applications for 3D printing in the development of electric propulsion systems, such as Hall Thrusters. Hall Thrusters feature intricate baffle geometries in the anode propellant distributor, and a potential for cost reduction exists if this component can be simplified through the use of 3D printing. In addition, 3D printing can enable unconventional channel geometries, propellant distribution systems, and magnetic circuit designs with the potential to improve Hall Thruster performance parameters. However, electric propulsion systems also present unique material requirements not shared by chemical propulsion systems, such as needs for high magnetic permeability or sputter resistance. New additive manufacturing processes may soon be able to accommodate these material requirements, paving the way for application of 3D printing to Hall Thruster design. We've reviewed advances in 3D printing of magnetic materials, high temperature materials, and conductive materials as they relate to Hall Thruster design as part of research activities looking to incorporate 3D printed components into Hall Thrusters. This paper provides an overview of recent additive manufacturing developments as they relate to Hall Thruster manufacturing. In addition, we discuss some of our experiences with testing a small Hall Thruster with additively manufactured components.