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Thermal property and microstructure measurements for additively manufactured parts with novel alloys (C-003 Thermal Properties)

Louisiana Board Of Regents

Prof. T. Gregory Guzik

The targeted research topic of this application is C-003: Materials and Processes Improvements for Chemical Propulsion State of Art (SoA). Chemical Propulsion Systems use chemical reactions to release energy and accelerate gases to generate thrust. There are three major components that make up chemical propulsion systems, including the Propellant Delivery/Feed System, the Thrust Chamber Assembly, and Thrust Vector Control systems. Both the Thrust Chamber Assembly and Thrust Vector Control systems operate at high temperature/high pressure, thus require careful thermal control and detailed material thermal property data for design optimization.

This team will evaluate the bulk thermal properties of novel materials made by additive manufacturing (AM). AM creates unique opportunities to fabricate parts with complex geometries, such as thrust chamber assembly for the chemical propulsion systems. Build on the established collaborations with NASA Marshall Space Flight Center (MSFC) Additive Manufacturing team (Paul R. Gradl), the Science-PI's team will characterize and test novel chemical propulsion components made by laser powder bed fusion (LPBF) based additive manufacturing (AM). Specifically, the Science PI's team will focus on thermal property measurements and microstructure evaluation of additively manufactured parts made of new NASA-developed oxide dispersion strengthened (ODS) alloys. The new alloys have shown high temperature capabilities and high strength at nearing 1100ºC. NASA scientists believe this new type of alloy is a critical and enabling material for high temperature capabilities for propulsion and would work well in chemical propulsion (C-003), such as liquid rocket engine propulsion systems, and even aviation engines. At the moment, there are no thermophysical property data for AM parts made with this new type of NASA alloys, thus limiting the design optimization for chemical propulsion components using the state of art AM manufacturing technology and novel alloys. The objective of this application is to fill the knowledge gaps by generating thermal diffusivity, thermal conductivity, specific heat, and density data, and by examining the microstructure evolution at high temperatures for the new alloy AM parts.