Additively Manufactured Inconel718-Methanol Heat Pipe: Fabrication and Low Temperature Thermal Testing.

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Abstract: Effective thermal management is crucial in hypersonic flight (Mach > 5) due to extremely high aerodynamic heating located at leading edges. Historically, passive and active thermal protection systems (TPS) have been used to achieve this purpose. Among passive TPS methods are two-phase thermal management systems, also known as heat pipes. Heat pipes can achieve extremely high thermal conductivity which makes them an attractive TPS solution. However, conventional fabrication methods for heat pipes and other two-phase thermal management devices require multiple manufacturing and assembly steps which limit design space. Additive manufacturing is a fabrication technology in which components are fabricated layer-by-layer to achieve net-shape geometry from CAD. AM is able to create complex geometries, incorporate internal channels, and consolidate assemblies. Hence, the ability to additively manufacture leading-edge heat pipes would bypass conventional manufacturing limitations and achieve a larger design space for lightweight, highly conductive leading-edge concepts. This presentation presents the fabrication and low-temperature thermal testing of a notional inconel718 leading edge heat pipe fabricated via laser-powder bed fusion AM and filled with methanol. This work serves as a proof of concept and precedes simulated-environment high-temperature thermal performance assessment of additively manufactured inconel718 leading-edge heat pipes filled with sodium.