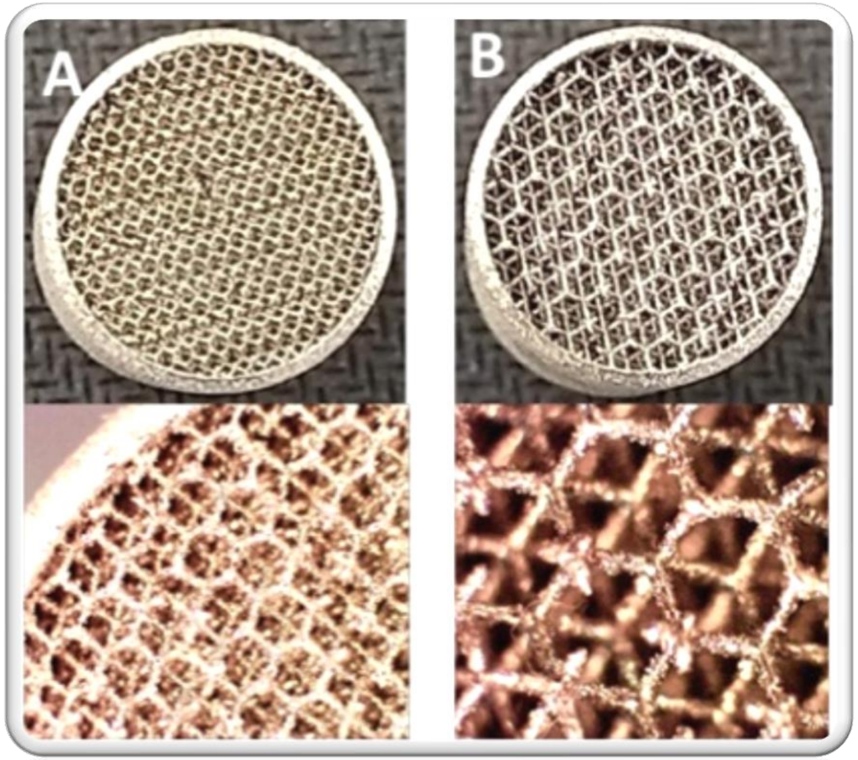
Research Thrust-1: Additively Manufactured Systems for Space Applications

Sub-Project 1: Investigating Additively Manufactured Graded Wick for Space Thermal Management System

Statement of R&D Problem

Two-phase passive heat transfer devices enjoy strongly increasing attention, in which Heat pipes, as passive heat transfer devices, operate by utilizing the latent heat of an internal working fluid. In heat pipe design, wick performance is often a limiting factor. Common homogeneous wicks for heat pipes are made of grooves, wrapped screens or sintered metal solutions. Such homogenous shapes stem from manufacturing constraints and influence the wick's performance. Recently, much research is devoted to more advanced composite wicks including composite screens and screen-covered grooves. These solutions provide high-capillary pressure and high permeability, but also require complex manufacturing steps. With current advances in metal 3D printing, an additively manufactured porous wick structure could well be an alternative, offering small-scale feature sizes and 3D ligament arrangements in a variety of possible configurations.



Statement of R&D Problem

In this case, 3D printing allows much greater freedom in defining the wick geometry and properties – in this paper, we therefore investigate experimentally the wick quality with potential use in heat pipes in mind. The main benefit of a 3D-printed wick is in the fabrication of a freeform porous structure with complex geometry and optimized internal pore structure, which can be integrated flexibly without introducing further interfaces, as a single manufactured heat pipe. This will result in a significant improvement of the rate with which heat can be removed, potentially, leading to an important breakthrough in thermal management systems. Research specifically aimed at 3D printing porous structures for two-phase heat transfer devices is scarce (Fig. 2).