Thermal Conductivity Measurements of 3D Printed Materials and High Performance Insulations at Cryogenic Temperatures

Ian Richardson [S] and Patrick Adam
Protium Innovations LLC, Pullman, WA, U.S.A.

Jacob Leachman [C]
School of Mechanical and Materials Engineering, Washington State University, Pullman, WA, U.S.A.
jacob.leachman@wsu.edu

The expansion of 3D printing and additive manufacturing into industrial and commercial applications has drastically changed manufacturing capabilities while expanding the material options available to cryogenic engineers. Unfortunately, these new materials are not well characterized, especially at cryogenic temperatures. A recently developed 3D printed liquid hydrogen fuel tank for unmanned aerial vehicles has expanded the use of Selective Laser Sintered (SLS) printed nylon blends to cryogenic temperatures and expedited the need for accurate thermal transport data. Moreover, this new material structure paradigm presents novel opportunities for integration of high-performance cryogenic insulations. A recently developed insulation that combines aerogel with polyimide to form a light-weight rigid foam is an ideal insulator for aerospace applications. However, no thermal conductivity data are currently available for this aerogel foam material. To address these needs, an experiment was designed and constructed for cryogenic thermal conductivity measurements. The results of thermal conductivity measurements of 3D SLS printed nylon blends and polyimide insulations are presented for temperatures between 20 and 297 K. Comparisons are made to traditional forms of the materials.