Thermal Modeling Techniques for Additively Manufactured Porous Metals

A Master's Thesis Defense in Mechanical Engineering

California Polytechnic State University, San Luis Obispo

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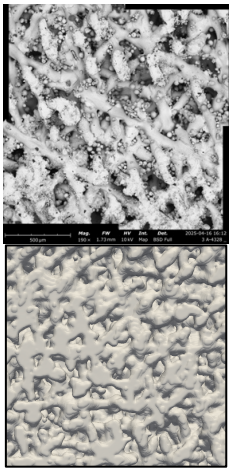

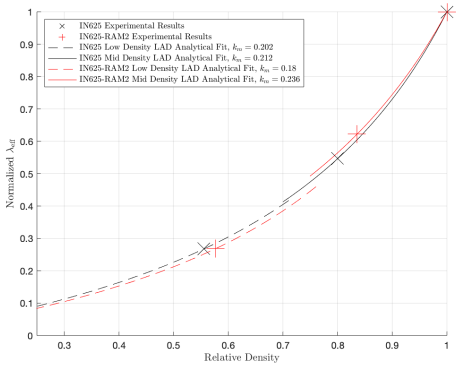

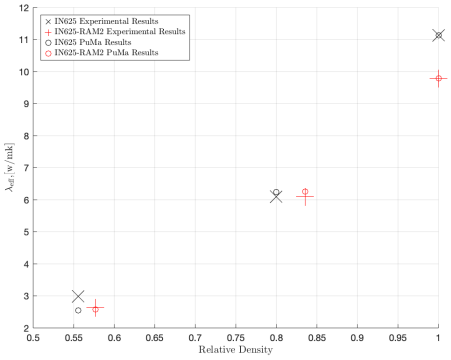

Advances in additive manufacturing have enabled the creation of metallic components with tailored porosity, offering design flexibility for thermal, structural, and fluid transport applications. This thesis investigates the effective thermal conductivity (ETC) of porous Inconel 625 (IN625) and Inconel–ceramic composites (IN625-RAM2) fabricated by Laser Powder Bed Fusion (LPBF) using Elementum 3D's PermiAM technology. Experimental measurements of thermal conductivity using the laser flash method are compared to numerical models built from micro-computed tomography data. Simulations were performed using both finite element (FE) and finite volume (FV) methods to evaluate thermal transport in real microstructures. The study investigates the effects of micro- and macro-scale structural features on ETC and shows that voxel-based FV modeling in PuMa can predict ETC within 3% of experimental values. Analytical models are also fit to experimental data to extend ETC predictions across a wider range of porosities. This work provides a framework for simulating the thermal performance of complex porous metals and supports future materials-by-design approaches targeting specific thermal properties in additively manufactured structures.

Thursday, June 5th, 2025, 1:10 PM. Building 13, Room 109

Zoom Meeting ID: 894 7869 7689, https://calpoly.zoom.us/j/89478697689