11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Design Optimization and Simulation of 3-D Woven Lattice Materials

Seung-Hyun Ha[1], Longyu Zhao[2], Yong Zhang[2], Stephen Ryan[2], Kevin Hemker[2], Tim Weihs[2], and James Guest[2]

[1]Korea Maritime and Ocean University, Busan, South Korea
[2]Johns Hopkins University, Baltimore, MD, USA

Abstract

This talk will discuss the design and modeling of porous metallic lattice materials manufactured from a 3-D weaving process. The woven material is characterized as having wires positioned orthogonally in three-directions. Topology optimization is applied using a ground structure approach to optimize the wire architecture with the goal of maximizing the effective properties of the bulk material, such as elastic moduli, fluid permeability, and/or thermal conduction. These properties are estimated from homogenization which computationally evaluates the material properties from the unit cell design. Several design examples are presented for the case of 3D woven materials manufactured from 200-micron diameter copper wires. Modeling of the mechanical, fluid, and heat transfer behavior are presented, and the optimized designs are manufactured and tested experimentally, which shows enhanced performance compared to conventional designs.

[1] Longyu Zhao, Seunghyun Ha, Keith Sharp, Andrew Geltmacher, Richard Fonda, Alex Kinsey, Yong Zhang, Stephen Ryan, Dinc Erdeniz, David Dunand, Kevin Hemker, James Guest, Timothy P. Weihs, "Permeability measurements and modeling of topology-optimized metallic 3-D woven lattices," Acta Materialia. Vol. 81, 2014, pp. 326-336.