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TOPOLOGY OPTIMIZATION OF STRAIGHT-CHANNEL COOLING STRUCTURES FOR EFFICIENT HEAT TRANSFER AND MECHANICAL BEHAVIORS

Mingdong Zhou[1] and Xi Zhao[2]

[1] State Key Laboratory of Mechanical System and Vibration, Shanghai Key Laboratory of Digital Manufacture for Thin-walled Structures, Shanghai Jiao Tong University, No. 800 Dong Chuan Rd. Shanghai 200240, P.R. China. Email: mdzhou@sjtu.edu.cn

[2] School of Automobile Engineering, Dalian University of Technology

Abstract

This work introduces an efficient topology optimization approach for coupled thermofluidic-mechanical problems to design structures containing straight cooling channels. Instead of solving a full-blown but computationally expensive thermofluidic solver, a simplified thermofluidic model together with a multiphase parameterization based on the Solid Isotropic Material with Penalization (SIMP) model are developed to design the cross section of the device that consists of solid, fluid and void phases. A design-dependent convection boundary scheme is proposed to allow continuous interpolation of the dynamic heat sinks among multi-phases as well as to ensure a pertinent thermofluidic simulation. Numerical examples that considering the engineering requirements on lightweight, uniform structural deformation tolerance and temperature distribution are given to demonstrate the applicability of the approach. Verifications of the optimized 3D structures by a full-blown thermofluidic simulation show that the proposed approach can yield lightweight channel-cooling structures with desirable heat-transfer and load-carrying capabilities subject to external heat flux and pressure loads.