

# 2D Dual Layer Thermo-Fluidic Sensitivity Analysis and Topology Optimization

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**Abstract:** The design of coupled thermo-fluidic systems is often non-intuitive. Starting with the pioneering work of Borrvall and Petersson on topology optimization of Stokes flows [1], gradient-based flow topology optimization approaches have been utilized to obtain optimal designs for fluids without the need for close-to-optimal initial designs. Using both Navier-Stokes [e.g. 2, 3] and kinetic theory based flow solvers [e.g. 4], steady-state flow topology optimization methodologies have been developed for pure fluid flows and various multi-physical flow phenomena in recent years, including 2D coupled heat and mass transfer problems [e.g. 5, 6]. While these approaches have shown great promise and have been implemented in commercial software packages such as COMSOL, 3D effects must be considered for many heat transfer applications, often leading to prohibitive numerical costs for a straight-forward extensions of the existing 2D approaches to 3D problems.

In this work, we extend the application of thermo-fluidic topology optimization approaches for two dimensional problems to pseudo 3D problems by including a thermal ground structure that models 3-dimensional conduction effects. Thus, while the fluid flow is treated as a 2D problem, heat transfer can occur in 3 dimensions, permitting topology optimization of e.g. lab-on-a-chip devices. The authors have developed the corresponding analysis and sensitivity analysis algorithms using an explicit lattice Boltzmann method (LBM) based solver. Utilizing the developed approaches, the authors will present initial topology optimization results for heat sinks.

**Keywords:** *design optimization, topology optimization, sensitivity analysis, heat and mass transfer, lattice Boltzmann method*

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