

## A Level-set Method for Optimizing the Topology of Cooling / Heating Devices using Natural Convection

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This paper is concerned with topology optimization of cooling/heating devices using natural convection. In the past such problems were studied by traditional density approaches, most often employing simple, out-of-plane convection models at the upper and lower surfaces of a two-dimensional design space (Bruns, T.E., Topology optimization of convection-dominated, steady-state heat transfer problems, *International Journal of Heat and Mass Transfer*, 50 (2007) 2859-2873). Density approaches typically lead to small features described by material distributions with intermediate densities; therefore the geometry of the device can not be clearly identified.

In this work we present an alternative approach combining level-sets to describe the geometry and the extended finite element method (XFEM) to predict the temperature fields and heat fluxes. This approach leads to a crisp definition of structural boundaries and takes advantage of the inherent capabilities of XFEM to impose complex boundary conditions on structural surfaces. Here we consider convection at the in-plane boundaries with and without out-of-plane surface convection and compare optimization results for different convection models. We demonstrate the advantage of the level-set/XFEM approach through comparison with the results for density based methods.