Topology optimization for nano-scale heat transfer

We consider the problem of optimal design of nano-scale heat conducting systems using topology optimization techniques. At such small scales the empirical Fourier's law of heat conduction no longer captures the underlying physical phenomena because the mean-free path of the heat carriers, phonons in our case, becomes comparable with, or even larger than, the feature sizes of considered material distributions. A more accurate model at nano-scales is given by kinetic theory, which provides a compromise between the inaccurate Fourier's law and precise, but too computationally expensive, atomistic simulations. We analyze the resulting optimal control problem in a continuous setting, briefly describing the computational approach to the problem based on discontinuous Galerkin methods, algebraic multigrid preconditioned generalized minimal residual method, and a gradient-based mathematical programming algorithm. Numerical experiments with our implementation of the proposed numerical scheme are reported.

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