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Viscous flow and heat transfer in channels with structured walls
VLADIMIR AJAEV, Southern Methodist University, STEFFEN HARDT, PETER STEPHAN, Center of Smart Interfaces, TU Darmstadt — We develop a mathematical model of pressure-driven flow in channels with walls structured by arrays of parallel grooves filled with air or gas. Motivated by cooling applications, we study heat transfer from a heater embedded in the wall to the liquid. The flow in the liquid is described using a Stokes flow model, and thermocapillary effects due to presence of the liquid-gas interface segments in the grooves are also taken into account. The rate of heat transfer is determined by a competition of two physical effects: the insulating effect of the gas in the grooves, due to small thermal conductivity of the gas phase, and the reduction of the effective slip length at the channel wall due to the presence of the liquid-gas interface segments in the grooves. Criteria for heat transfer enhancement are formulated for different parameters of the structuring.

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