Baby Shark, u u u u u u: The Effect of Nanoscale Fins on Velocity Autocorrelation and Heat Transfer at Fluid-Solid Interfaces

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Nanopatterned surfaces occur in a wide range of engineering applications and can exhibit many heat transfer phenomena that differ from their macroscale counterparts. Here, we present results from molecular-dynamics (MD) simulations in which we study the heat-transfer performance of surfaces patterned with a variety of nanoscale fin structures. In MD simulations of a variety of fluid-solid pairings, we find that nanoscale fins can induce significant fluid structuring effects at the fluid-solid interface as well as anomalous fluid diffusion in the vicinity of the boundary. We demonstrate that the magnitude of fluid structuring and the anisotropy of diffusivity can be accurately estimated using models based upon molecular mechanics. We also show results on the heat transfer coefficient in the system as a function of fluid pressure and fin geometry (as parameterized by size and aspect ratio). These results differ from the results of classical fin theory. We conclude by exploring the microscopic underpinnings of these differences; in particular, we examine the velocity autocorrelation and vibrational density of states of fluid molecules near the fluid-solid interface.