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Modeling the combined effect of surface roughness and shear rate on slip flow of simple fluids ANOOSHEH NIAVARANI, NIKOLAI PRIEZJEV, Michigan State University — Molecular dynamics (MD) and continuum simulations are carried out to investigate the influence of shear rate and surface roughness on slip flow of a Newtonian fluid. The nonlinear shear-rate dependence of the intrinsic slip length in the flow over an atomically flat surface is computed by MD simulations. We describe laminar flow away from a curved boundary by means of the effective slip length defined with respect to the mean height of the surface roughness. Both the magnitude of the effective slip length and the slope of its rate-dependence are significantly reduced in the presence of periodic surface roughness. We then numerically solve the Navier-Stokes equation for the flow over the rough surface using the rate-dependent intrinsic slip length as a local boundary condition. Continuum simulations reproduce the behavior of the effective slip length obtained from MD simulations at low shear rates. The slight discrepancy between MD and continuum results at high shear rates is explained by examination of the local velocity profiles and pressure distribution along the wavy surface. We found that in the region where the curved boundary faces the mainstream flow, the local slip is suppressed due to the increase in pressure.

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