Pressure dependence of lubricant viscosity and load dependence of superlubricity

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The talk will first describe non-equilibrium molecular dynamics (MD) simulations of the viscosity of the model lubricant squalane. Theoretical results from 10^5 s-1 to 10^{11} s-1 extrapolate smoothly to experimental results for 10^4 s^{-1} and below. At room temperature, the entire range is fit by an Eyring model with a constant Eyring stress over pressures from 0 to 1 GPa as the Newtonian viscosity η rises from 10^{-2} to 10^4 P. Simulations show that $\log_{10} \eta$ rises sublinearly with pressure past 3 GPa, implying that there is no divergence of viscosity at finite pressure. Simulations are also consistent with experimental results for η at temperatures down to 160 K. Comparing high and low pressure results suggests there is also no divergence of η at a finite temperature. The implications for models of elastohydrodynamic lubrication will be discussed. The second part of the talk will describe the effect of elasticity beyond the surface on superlubricity in single asperity contacts. As the contact radius increases there is a transition from coherent superlubric motion to dislocation mediated sliding. Three regimes are identified depending on the ratio of contact radius to the core size of interfacial dislocations. At large loads (contact radii), elasticity prevents true superlubricity with vanishing friction. Instead the friction saturates at a value that is surprisingly similar for commensurate and incommensurate surfaces.