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Elastic deformations disrupt structural superlubricity in large contacts[1] TRISTAN A. SHARP, Johns Hopkins University, LARS PASTEWKA, Karlsruher Institut fr Technologie, MARK O. ROBBINS, Johns Hopkins University — Force microscopy experiments observe ultra-low friction between solids with incommensurate lattice structures. This phenomenon is referred to as superlubricity and is due to a cancellation of lateral forces because surfaces sample all relative local configurations with equal probability. We use simulations to show that elasticity disrupts superlubricity in sufficiently large circular contacts. The simulations include atomic-scale geometry and reach micron-scales. For rigid solids, cancellation is complete except at the contact boundary. The static friction force per contact area, τ, falls as a power of contact radius, $\tau \sim a^{-3/2}$. Elastic deformations limit this cancellation when the contact radius a is larger than a characteristic length scale set by the core width of interfacial dislocations, b_{core}. For $a > b_{core}$ sliding of moderately incommensurate contacts is dominated by dislocation motion and, at large a, τ approaches a constant value near the Peierls stress needed to move edge dislocations. Surprisingly, the stress in commensurate contacts drops to nearly the same value at large a. We conclude that true structural lubricity does not occur in large contacts, although the constant shear stress drops rapidly with b_{core}.

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