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When are rough surfaces sticky?[1] LARS PASTEWKA, Fraunhofer Institute for Mechanics of Materials IWM, MARK ROBBINS, Johns Hopkins University, Department of Physics and Astronomy — Van-der Waals interactions operate between all surfaces and are strong enough to hold 1000kg per square centimeter. Yet, few surfaces are adhesive. This discrepancy between atomic and macroscopic forces is due to roughness and has been dubbed the adhesion paradox. To quantify this behavior, we carried out molecular statics and continuum simulations of the contact area, stiffness and adhesion between rigid, randomly rough surfaces and elastic substrates. The surfaces are self-affine with Hurst exponent 0.3 to 0.8 and different short and long wavelength cutoffs. The rms surface slope and the range and strength of the adhesive potential are also varied. For parameters typical of most solids, the effect of adhesion decreases as the ratio of long to short wavelength cutoff increases. In particular, the pull-off force decreases to zero and the area of contact A becomes linear in the applied load L. A simple scaling argument is developed that describes the increase in the ratio A/L with increasing adhesion and a corresponding increase in the contact stiffness. The argument predicts a crossover to finite contact area at zero load when surfaces are exceptionally smooth or the ratio of surface tension to bulk modulus is unusually large, as for elastomers.

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