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A physical basis for frictional ageing using single-asperity measurements QUNYANG LI, University of Pennsylvania, DAVID GOLDSBY, TERRY TULLIS, Brown University, ROBERT CARPICK, University of Pennsylvania — Rate and state friction laws are widely used to model laboratory data and reproduce a variety of phenomena in earthquake modeling, and in other multi-asperity contacts. However, these laws lack a physical basis. To identify mechanisms underlying the time dependence of friction, especially the ageing effect, atomic force microscopy (AFM) was employed to probe friction for nanometer-scale single asperity contacts between oxidized silicon AFM tips and a set of substrates. Similar to macroscopic rock friction experiments, 'slide-hold-slide' (SHS) experiments on silica revealed a linear increase in friction with the log of the hold time. However, SHS experiments on chemically inert substrates showed little to no ageing. This indicates that the ageing mechanism is related to interfacial chemical reactions, and not plastic deformation of asperities. Ageing in silica-silica contacts is more than an order of magnitude higher than for macroscopic interfaces. However, modeling of slip in multi-asperity contacts suggests that the single- and multi-asperity results agree, since the magnitude of the ageing effect in multi-asperity contacts is reduced by asperity interactions. These results provide the first asperity-level insights into possible mechanisms behind rate and state friction laws.

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