SWITCHABLE FRICTION AT RANDOMLY ROUGH MULTI-ASPERITY INTERFACES THROUGH CAPILLARY CONDENSATION?

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ABSTRACT
Under ambient conditions, almost all surfaces are covered by a thin water layer. Silicon oxide for instance is covered by 0-3 nm of water as the relative humidity of the surrounding air is varied from 0-100%[1]. Whenever two surfaces that are covered by such water layers – for instance an AFM tip and a silicon oxide substrate - approach to within a few nanometers, a capillary bridge can form around the contact point[2] and contribute to the contact force, and thus to the friction force. The attractive force exerted by a single capillary bridge is well understood[3-5] and roughly equal to the product of its circumference and the water surface tension. At an interface with roughness, the total contact circumference over which capillary effects can contribute to the effective normal force – and thus the friction - is not trivial[6]. The larger this circumference[7], however, the larger the contrast in friction measured in dry or humid environments. In order to establish friction that can be switched from low to high and vice versa, by externally changing the humidity, we therefore need to understand the roughness- and humidity-dependent capillary force.

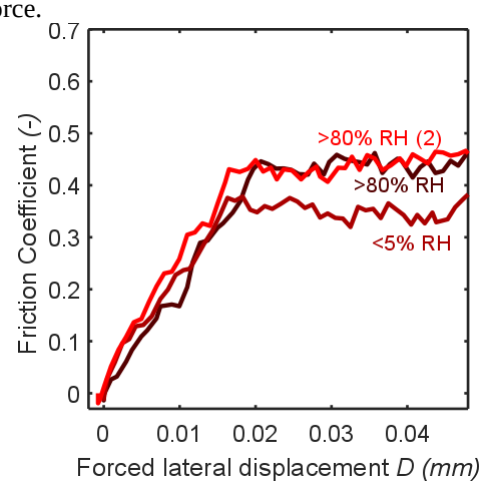

Fig.1 Friction coefficient measured at the interface between a rough SiC ball and a smooth Si wafer. The friction can be switched from high to low and back by changing the relative humidity of the surrounding air.

Here we will present rough sphere-on-smooth substrate friction experiments, conducted in a controlled humidity environment. We will show that friction can be switched from low to high and vice versa by changing the humidity, and compare the friction measurements to multi-asperity contact models that account for capillary effects.

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