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Dewetting in Soft Contacts: Role of Surface Energies

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Under wet conditions, the contact mechanics and friction of soft interacting solids such as rubber, hydrogel, and biological tissue, is dramatically affected by the occurrence of interfacial dewetting transition. In-situ soft contact tribometry is here adopted to shed light on the role of dispersive and polar surface energies on the contact formation and fluid squeeze out.

Keywords (from 3 to 5 max): soft contacts, dewetting, surface energy, friction, adhesion

The research focuses on the fundamental investigation of adhesion properties and contact formation of soft polymers in dry and lubricated conditions. Wetting/dewetting regulates the transition from dry to lubricated contacts, across the many length scales characterizing the roughness of real interacting solids. Thus, friction in the boundary/mixed regime is dominated by wetting/dewetting phenomena. Polymer friction is critical in many applications, ranging from automotive tires and seals, to biomedical and robot applications.

The adhesive contacts between functionalized soft elastomeric dome and functionalized flat glass surface are studied with the help of a newly developed experimental setup. The setup is composed of an opto-mechanical apparatus capable of bringing a PDMS dome into contact with a glass plate, with controllable kinematics of normal and sliding displacement, in presence of fluid. The real area of solid contact is determined recurring to phase contrast or fluorescence, depending on the nature of the mating solids/fluids.

Typically, the Sylgard 184 PDMS kit [prepolymer (base) and a cross-linker (curing agent)] is used to achieve a fully cross-linked optically-smooth PDMS dome, with radii d=25 mm, d=50 mm, d=75 mm. Fused silica glass plate (75mm x 25mm x 1mm) is used as countersurface. Both the surfaces have been functionalized to change their polar and dispersive surface energy components, leading to a plethora of different wetting/dewetting dynamics behavior.

The developed experimental set-up for the investigation of the adhesion phenomena occurring during soft smooth interactions can provide a detailed understanding on how wetting phenomena relate to adhesion and can be the physical input parameters for microscale contact mechanics models.