EGU21-14445
https://doi.org/10.5194/egusphere-egu21-14445
EGU General Assembly 2021

Bridging the failure of surface asperities to the macroscopic rupture energy during the onset of frictional sliding

Fabian Barras[1], Ramin Aghababaei[2], and Jean-François Molinari[3]
[1]The Njord Centre, University of Oslo, Oslo, Norway
[2]Engineering Department, Aarhus University, Aarhus, Denmark
[3]Civil Engineering Institute, Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland

The onset of sliding between two rough surfaces held in frictional contact arises through the nucleation and propagation of rupture fronts, whose dynamics has been shown to obey the elastodynamics of a shear crack. By analogy with the fracture energy controlling the growth of brittle crack in intact material, a frictional rupture is governed by an associated rupture energy. In the context of earthquakes, this rupture energy is expected to control the nucleation and the transition from an accelerating slip patch or localized perturbation to a propagating seismic rupture. The microscopic origin of this rupture energy and its relation to the microcontacts topography remain however unsettled.

In this context, this study aims at bridging the macroscopic description of friction to the failure of contacting asperities and frictional wear prevailing at smaller scales. Recent studies demonstrated how the failure of two contacting asperities arises either by plastic deformation or brittle failure of their apices depending on whether their contact junction is respectively smaller or larger than a characteristic length scale. In this study, we investigate numerically how the different failure mechanisms of microcontact asperities impact the nucleation and propagation of frictional rupture fronts.

At a macroscopic level, we study the ability of an interface to withstand a progressively applied shearing, i.e. its frictional strength, while at the microscopic scale, we observe how the failure process develops across the microcontact junctions. We highlight how the microcontacts topography significantly impacts the nucleation and frictional strength, even when comparing interfaces with identical macroscopic properties and rupture energy. We present how the characteristic length governing microcontacts failure can be used to select which details of the surface roughness are homogenized along the tip of a nucleating slip front. Combining the approach proposed in this work with models solving normal contact between rough surfaces will open up new prospects to study the strength and rupture energy of frictional interfaces at the onset of sliding.