Evolution of roughness during dry sliding: insights from atomistic and mesocale models

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We will discuss recent advances in developing a fundamental, mechanistic, understanding of the evolution of surface roughness of solids under dry sliding. The time evolution of surface roughness crucially impacts friction and wear and is unfortunately little understood. Wear models are for the most part empirical, and the development of physics-based predictive models will require intensive experimental, theoretical and numerical research at various scales. This presentation focuses on atomistic and mesoscale numerical modelling of rough solids under sliding in the presence of adhesive wear mechanisms.

In the first part, we will summarize our attempts at capturing debris formation at micro contacts using coarse-grained atomistic potentials [1,2]. We will show that, in the simple situation of an isolated micro contact, the final debris size scales with the maximum junction size attained upon shear. This permits to draw analogies with Archard adhesive wear model [3]. In the second part, this single-asperity understanding will be incorporated in a mesoscale model [4], which aims at estimating from first principles the wear coefficient, a notoriously little understood parameter in wear models. We estimate the amount of volume of debris formed for a given applied load, using the probability density of micro contact sizes. A crucial element of this mesoscale model is the distribution of surface heights, which should evolve as wear processes take place. This will lead us, in the final part, to a discussion of recent simulations aiming at understanding the long term evolution of surface roughness.

References

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