

GRADUATE SEMINAR

Toward a Mechanistic Understanding of Adhesive Wear

**Jean-Francois Molinari – Director, Computational Solid Mechanics
Laboratory, Ecole Polytechnique Fédérale of Lausanne (EPFL), Switzerland**

We discuss recent advances in developing a fundamental, mechanistic, understanding of the evolution of surface roughness of solids during dry sliding. The time evolution of surface roughness is little understood although it crucially impacts friction and wear. Engineering 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 summarize our attempts at capturing debris formation at micro contacts using atomistic potentials. We 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. In the second part, this single-asperity understanding is incorporated in a mesoscale model, 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 leads us, in the final part, to a discussion of recent simulations aiming at understanding the long term evolution of surface roughness. These long time scales simulations reveal the emergence of self-affine fractal surfaces irrespective of the initial surfaces characteristics.



Professor J.F. Molinari is the director of the Computational Solid Mechanics Laboratory (<http://lsms.epfl.ch>) at EPFL, Switzerland. He holds an appointment in the Civil Engineering institute, which he directed from 2013 to 2017, and a joint appointment in the Materials Science institute. He started his tenure at EPFL in 2007, and was promoted to Full Professor in 2012. He is currently an elected member of the Research Council of the Swiss National Science Foundation in Division 2 (Mathematics, Natural and Engineering Sciences).

J.F. Molinari graduated from Caltech, USA, in 2001, with a M.S. and Ph.D. in Aeronautics. He held professorships in several countries besides Switzerland, including the United States with a position in Mechanical Engineering at the Johns Hopkins University (2000-2006), and France at Ecole Normale Supérieure Cachan in Mechanics (2005-2007), as well as a Teaching Associate position at the Ecole Polytechnique de Paris (2006-2009). He received an ERC Starting Grant award in 2009.

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