Department of Aerospace and Mechanical Engineering

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Atomic-Scale Processes in Single Asperity Friction and Wear

Wednesday, September 24, 2014, 3:30P.M.

Carey Auditorium, Hesburgh Library

Refreshments served at 3:00 p.m. outside of Carey Auditorium

I will discuss recent atomic force microscopy studies of nanoscale single asperity contacts that reveal surprising new behavior and insights. First, the behavior of nanoscale contacts with truly 2-dimensional materials will be discussed. For nanoscale contacts to graphene, we find that the friction force exhibits a significant dependence on the number of 2-D layers. An even stronger effect occurs when graphene is fluorinated, where experiments and simulations both show that friction between nanoscale tips and fluorinated graphene (FGr) monolayers exceeds that for pristine graphene by an order of magnitude. The results can be interpreted in the context of the Prandtl-Tomlinson model of stick-slip friction.

I will then discuss new insights into the physics of nanoscale wear. A better understanding of wear would allow the development of rational strategies for controlling it at all length scales, and would help enable applications for which wear is a primary limitation such as micro-/nano-electromechanical systems (MEMS/NEMS). We have demonstrated the ability to characterize single-asperity wear with a high degree of precision by performing in-situ wear tests inside of a transmission electron microscope. For silicon probes slid against a flat diamond substrate, the shape evolution and volume loss due to wear are well described by kinetic model based on stress-assisted chemical bonding mechanisms. This allows new insights to be gained about the kinetics of atomic-scale wear.

Dr. Robert Carpick
John Henry Rowne Professor & Chair of Mechanical Engineering & Applied Mechanics
University of Pennsylvania School of Engineering & Applied Science, Pennsylvania

If you are interested in meeting individually with Dr. Carpick, please contact Emily at 631-5431.

Midwest Mechanics Seminar Series