Atomic Scale Friction: From Understanding to Control.

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Interfacial friction is one of the oldest problems in physics and chemistry and certainly one of the most important from a practical point of view. Due to its practical importance and the relevance to basic scientific questions, there has been a major increase in the activity of the study of interfacial friction on the microscopic level during the last decade. New experimental tools have been developed that allow for detailed investigations of friction at nanometer length scales, a range of related processes which have been termed nanotribology. Intriguing structural and dynamical features have been observed experimentally in nanoscale molecular systems confined between two atomically smooth solid surfaces. These include, for example, stick-slip motion, intermittent stick-slip motion characterized by force fluctuations, transition to sliding above the critical velocity, and a dependence of friction on the history of the system. These and other observations have motivated theoretical efforts, both numerical and analytical, but most issues are still subject to controversy.

In this lecture I will present a minimalistic model which includes most of relevant microscopic parameters needed to obtain the above experimental observables. The relationships between the properties of the embedded system and the frictional forces will be discussed. Methods to control friction will be described which enable to eliminate chaotic stick-slip motion, and modify frictional forces. The approach discussed in the lecture leads to a new look at this old problem and to predictions amenable to experimental tests.