Using Small Vibrations to Control Friction at the Nanoscale

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We studied the response of a nano-array of atoms to the mechanical vibration of their substrate, within a minimalist model of friction. Our motivation is threefold, namely: (i) understanding the basic mechanisms of frictional response to small periodic and random perturbations; (ii) developing robust control techniques for friction; and (iii) assessing size effects on friction control. Numerical simulations of the model suggest that the friction coefficient under go a sharp transition to very small values when the amplitude of the vibration reaches a critical threshold. We find a strong correlation between the friction coefficient and the phase synchronization of the sliding array. In particular, at the transition point, we observe a significant increase in the phase synchronization of the array. We estimate analytically the transition point and contrast the effects of periodic and random surface vibrations on the friction coefficient. This work is supported in part by the Office of Basic Energy Sciences, U.S. Department of Energy, under contract No. DE-AC05-00OR22725 with UT-Battelle, LLC.