Non-intrusive measurements of frictional forces between microspheres and flat surfaces  

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— We report a novel, optical pump-probe experimental setup to study micro-friction phenomena between micro-particles and a flat surface. We present a case study of stainless steel microspheres, of diameter near 250$\mu$m, in contact with different surfaces of variable roughness. In these experiments, the contact area between the particles and the substrates is only a few nanometers wide. To excite the particles, we deliver an impulse using a pulsed, high-power laser. The reaction force resulting from the surface ablation induced by the laser imparts a controlled initial velocity to the target particle. This initial velocity can be varied between $10^{-5}$ to 1 m/s. We investigate the vibrating and rolling motions of the micro-particles by detecting their velocity and displacement with a laser vibrometer and a high-speed microscope camera. We calculate the effective Hamaker constant from the vibrating motion of a particle, and study its relation to the substrate’s surface roughness. We analyze the relation between rolling friction and the minimum momentum required to break surface bonding forces. This non-contact and non-intrusive technique could be employed to study a variety of contact and tribology problems at the microscale.

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