

Research Topic : **Transport and Manipulations of Micro-Particles on Dry Surfaces**
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 Sponsor(s) : **The National Science Foundation (NSF) and CAMP**
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Synopsis of Research and Sponsored Projects

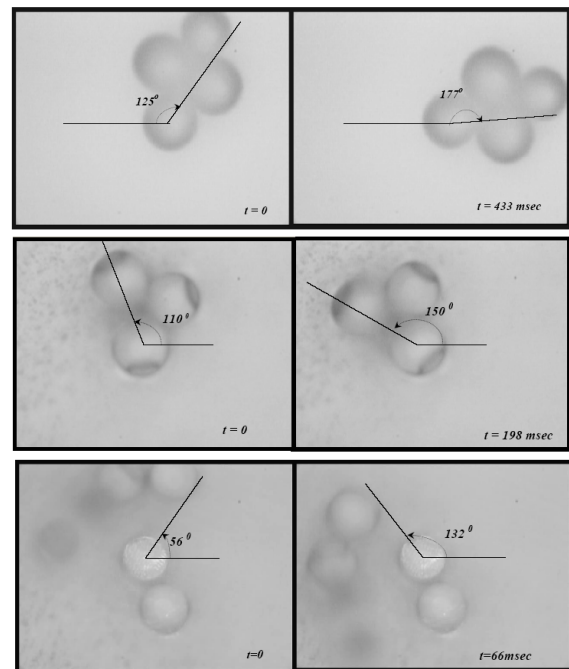
Gaining fundamental understanding of the transport and motion of small-scale objects on dry surfaces is the focus of this research effort. The needs in this area have been growing, as more micro/nano-technology applications require the transport and manipulations in nano/micro-scale. Our research efforts in this area focus on the transport and motion characteristic of micro-spheres under the influence of acoustic fields generated in solid substrates and in air by piezoelectric transducers.

Current particle motion and manipulation research in the literature mostly relies on AFM-based techniques. However, a major concern with AFM has been physical contact requirement with particles to be moved. Such contact can cause serious practical problems. As proposed by our group, one alternative mechanism is to excite the motion of particles by means of base excitation using high-frequency acoustic fields.

In our recent studies, generation of a class of particle pack motion on dry surfaces has been demonstrated. As the substrate is excited by an acoustic field consisting of short pulses with variable pulse repetitive rates, translating particles move along curved trajectories on the surface. Surface motion with nanometer level amplitudes is due to combination of axial and radial vibrational components of the substrate.

Due to the complex nature of the exciting base motion field, particle packs could make oscillatory motions on the surface. However, it is observed that, instead of forming a stiff bond with the stationary microsphere and becoming immobile, the free microspheres can rotate around a stationary particle and often make a single frequency rotational motion. The stability of these pack configurations is attributed to the rolling moment resistance between the particles in contact. This mode of motion of the packs is unanticipated since the driving acoustic field is not particularly a circular (or symmetric) field.

We also recently developed a non-contact adhesion measurement technique based on the acoustic base-excited rocking motion of microspheres. Transient out-of plane responses of 21 μm -PSL particles on the excited substrate are measured using an interferometer. The resonance frequency of the rotational motion is related to the work of adhesion of the particle and substrate materials by utilizing the rolling resistance of the particles. For the first time, the existence of rolling moment resistance of an adhesion bond between a microsphere and a flat surface has been experimentally demonstrated.



Recent Publications

1. M. D. Murthy Peri and C. Cetinkaya, *Air-Coupled Excitation of Rocking Motion of Individual Microspheres on Surfaces*, Applied Physics Letters, 90, 171906, 2007.
2. M. D. Murthy and Peri and C. Cetinkaya, *Rotational Motion of Microsphere Packs on Acoustically Excited Surfaces*, Applied Physics Letters, Vol. 86, 184103, 2005.