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AFM controlled studies of nanoscale polymeric spheres on a Si substrate

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The understanding of physical motions such as rolling, sliding, stick-slip, and spinning is of great importance, since the energy loss and wear between the contacting surfaces is determined by the mode of motion of these particles. When a lateral force is applied onto a nano size particle lying on a surface, what happens to its translational motion? Does it roll, does it slide, or both? How can the force required be predicted from the particle's properties? These questions have relevance in technological applications where nano size particles are used in lubricating mixtures and in nano-electromechanical devices, where they are used as building blocks. Using Lateral Force Microscopy to provide the forces required to produce translational motion of nano-sized particles across a planar substrate will help understand the tribological properties that inform their use in such applications. Such knowledge will help in designing new lubricants, hard disk storage technology, new materials for post chemical mechanical polishing (CMP), and generally in the reliable, repeatable and controllable manipulation of nano-size particles on substrates. We have utilized Atomic Force Microscopy and Force Spectroscopy to study the tribological properties of nanoscale polymeric particles to explore how the friction between these nanoscale spherical objects translating over planar substrates is related to interfacial energy and the mechanical properties for these particles. A technique for modifying the mechanical properties was developed and used to provide a set of samples over which we had control of the elastic modulus without corresponding changes in the chemical bonds. Lateral force microscopy was used to measure the force required to translate asymmetric, nanoscale particles of controlled size, surface chemistry and moduli. The effects of work of elastic modulus of polystyrene microspheres, contact radius between particle and substrate have been studied for the different modes of particle translation under an external force.

Biography

Himanshu Verma has done Masters in Physics from Michigan Technological University, Houghton, MI in 2006 and Ph.D. in Applied Physics from University of South Florida, Tampa, FL in 2015. Dr. Verma served as Assistant Professor of Physics in Southern Chicago with a community college for 1 year and about to begin investigation on Novel Magnetic Materials as Research Associate at Morgan State University in Baltimore, Maryland.

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