

**Introduction**

Understanding frictional interactions between surfaces is crucial for numerous practical applications, ranging from mechanical and tribological systems to electronic devices. The interaction between surface roughness and the adhesion or frictional forces that arise due to their alignment or misalignment is a fundamental topic in the field of tribology. The study of friction and adhesion at contact interfaces is essential for the development of materials and coatings that can withstand mechanical stresses and environmental conditions. This research invests in the understanding of these interactions to develop novel strategies for controlling friction and adhesion at interfaces.

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**Experimental Measurements**

- High resolution surface imaging
- Correlated friction and adhesion mechanics

**Theoretical Calculations**

- Atomically tailored structure and dynamics
- Substrate key factor and variables

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**Modeling Contact and Sliding of Thin Films**

Simulating Nanoasperity Contacts

Molecular dynamics simulations employ silica nanoparticles and disks to simulate flat and curved surfaces similar to those used in experiment. This allows us to study the effects of surface morphology on the contact and friction response of surface coatings and boundary lubricants.

**Contact Stress and Strain Analysis**

- Stress Analysis and Effective Lubrication
- Atomic Mechanisms of Friction in Graphene Films

**Friction and Adhesion of Graphene on Rough Surfaces**

**Raman Mapping & Strain Analysis**

- Due to sharp nanoasperity interactions the graphene is strained
- Analysis of the Raman spectra revealed small peaks attributed to strained strain in the graphene lattice due to the nanoasperity roughness of the substrate as compared to graphene films on flat surfaces.

**Surface Structure of Graphene Films**

- Graphene layers partially conform to nanoscale substrates

**Effect of Mechanical Loading**

- Deformation increases under increasing applied load

**Hydrophilic Rough Surfaces**

- Suppression of the “puckering effect” between sharp asperities

**Hydrophobic Surface Interactions**

- A significant contrast between the nanosurfaces modified with octadecyltrichlorosilane (OTS) and graphene layers can be easily seen in the AFM image. In this case, the friction was not found to depend on the contact area of the probe.

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**Strain Analysis and Tribocorrosion Growth**

- We have measured graphene on curved surfaces. Consistent with prior studies, a nanosurface is used to simulate the nanoasperity morphology. The graphene sheet is applied either as a spherical structure with defects than amorphous carbon rich or as a typical graphene sheet placed across a nanosurfaces. Comparison of these two structures illustrates the influence of curvature strain on the frictional dynamics and strain evolution in these materials under contact.

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