Three-Dimensional Force Imaging and Quantification with Atomic Resolution

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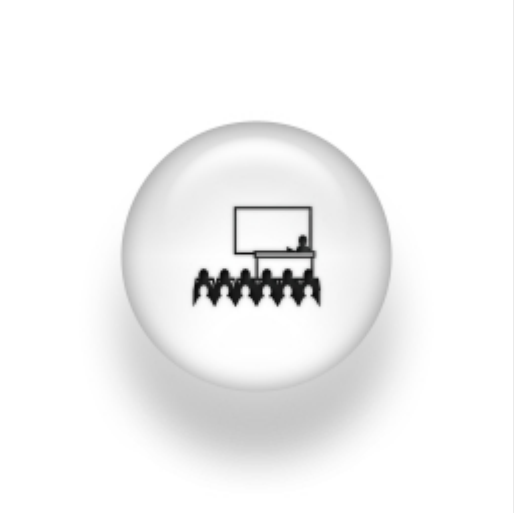

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ABSTRACT:
Site-specific chemical interactions at surfaces govern various scientific and technological fields including catalysis, thin film growth, and tribology.
Full control over design processes in these fields requires quantitative, site-specific knowledge of the surface force field with atomic resolution in three dimensions. Until now, such information has only been theoretically accessible. Here we demonstrate a noncontact atomic force microscopy-based approach to experimentally obtain this data and show that it can be used to image the three-dimensional surface force field of graphite, as well as the interaction potential and the dissipation. Graphite has been chosen due to its importance as a solid lubricant as well as a model for sp2-bonded materials. We show normal force maps with picometer and piconewton resolution that allow a detailed characterization of the distance-dependent surface-probe interactions in all directions. Within these maps, the positions of all atoms are identified, and differences between atoms at inequivalent sites are quantified. In addition, dissipation and lateral force characteristics of the surface are analyzed. The results suggest that the origin of graphite’s excellent lubrication properties may lay in a remarkable localization of the lateral forces.

Short Bio:
Mehmet Z. Baykara got his undergraduate degree from the Department of Mechanical Engineering at Bogazici University in Istanbul, Turkey with high honors in 2006. The same year he started his Ph.D. studies at Yale University under the supervision of Prof. Udo Schwarz. Currently he’s in the third year of his studies.