Exploring Solid-Liquid Interfaces by Frequency Modulation Atomic Force Microscopy

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Recent progress in dynamic force microscopy techniques operating in liquids has opened the possibility for us to explore the solid-solid interfaces, which play important roles in a wide variety of physical, chemical, and biological processes. We developed a low-noise and low-thermal-drift atomic force microscope (AFM) and demonstrated atomic resolution imaging of various inorganic samples (mica, graphite, etc) and molecular resolution imaging of biological samples such as proteins and DNA in liquids, employing frequency-modulation AFM (FM-AFM) [1-3]. Moreover, the state of the art two-dimensional (2D) and three-dimensional (3D) force mapping techniques with FM-AFM now allow us to collect the 2D and 3D frequency shift and force data at the solid-liquid interfaces. By precisely analyzing the oscillatory hydration force measured at the solid-liquid interfaces, we can visualize molecular-scale hydration structures at the interface. In this presentation, we will review the technical details of FM-AFM and 2D/3D force mapping techniques and present some recent experimental results obtained at the solid-liquid interfaces of clay minerals such as muscovite mica in water and ionic crystal surfaces such as alkali halides in their saturated solution.

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