# Force measurement by atomic force microscopy with a molecular tip at low temperature

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Recent progress in atomic force microscopy allows us to see inner structures of molecules adsorbed on surfaces [1]. In such measurements, a reactive metal tip is usually terminated by a small molecule or an inert rare gas atom. Such high-resolution imaging is beneficial to study single and self-assembled molecules as well as chemical reactions. Besides high-resolution imaging, force measurements became more reliable and even quantitative since the structure of the tip apex, at least the front-most-atom, can be controlled in experiment.

In this presentation, force spectroscopic measurements with different molecular tips (i.e. Xe-tip for van der Waals force detection [2] and CO-tip for the intermolecular bond detection [3]) will be discussed (Fig. 1). Besides the small atom and molecule, the tip can be also terminated with a large molecule or a polymer. By moving the tip vertically, we measured desorption phenomena of repeat polyfluorene units [4]. We found that the incommensurability between the unit length and the lattice distance plays a role in the friction. Since the fluorene units are connected to each other by a single bond, the incommensurability is not high. Using a stiffer material in-plane, a lower friction can be expected. In fact, the super lubricity was detected when graphene nanoribbon was slid on Au(111) [5].

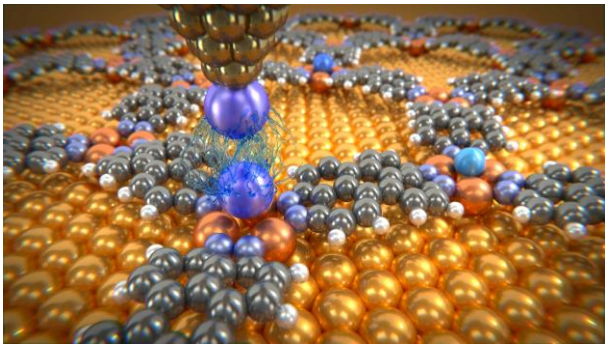

**Figure 1** Schematic drawing of the pair-wise van der Waals force measurement.

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