Measuring the force needed to roll a fullerene – Molecular manipulation of C_{60} on Si(100) 2x1 at room temperature

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Scanning Probe Microscopy (SPM) methods have been used to investigate the dynamics of atomic and molecular manipulation for over 30 years. Most examples of molecular manipulation are performed at low temperatures on metal surfaces [1], where the lower binding energy of the molecules makes them amenable to manipulation, and low temperatures inhibit thermal diffusion. Importantly, NC-AFM has the ability to elucidate the forces during atomic/molecular manipulation in a way not accessible to STM [2].

Manipulation at room temperature typically requires stronger adsorbate-surface binding to inhibit thermal diffusion (e.g. via the use of semiconductor surfaces) [3], but this enhanced bonding can also make manipulation more challenging due to the higher barriers, particularly for molecular adsorbates which can have multiple bonds. A notable example of controlled molecular manipulation at room temperature (RT) is the controlled positioning of C_{60} molecules on Si(100), which is known to move via a novel 'rolling' mechanism [4].

We have investigated the manipulation of individual C_{60} molecules on the Si(100) 2x1 surface at RT (Fig. 1) using cantilever-based NC-AFM. Acquisition of 2D force maps allows us to determine both the normal (F_z) and lateral (F_x) threshold force for inducing the motion of C_{60} both along, and across, Si dimer rows for a given tip apex. We use the reproducibility of the method to investigate the statistical variation of the manipulation process according to manipulation type.

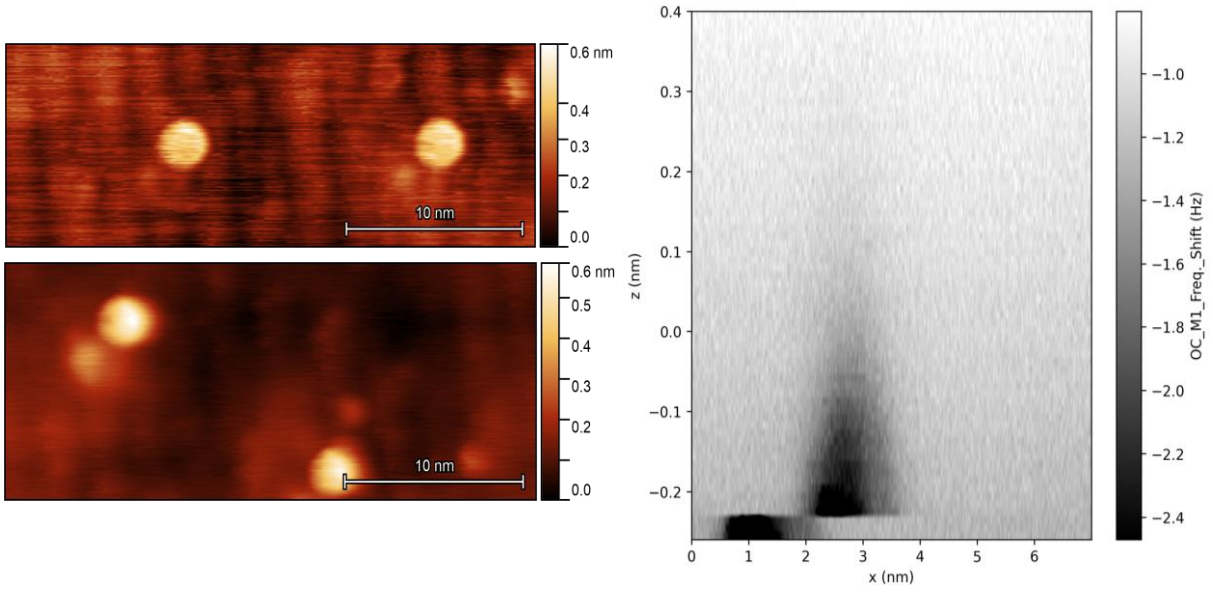

Figure 1: left - Constant frequency shift NC-AFM images of C_{60} on Si(100) at room temperature, before (top) and after (bottom) manipulation of leftmost C_{60} molecule . **Right** – xz-frequency shift map showing manipulation event.

References

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[3]: *Sugimoto, Y. Science 322.5900 (2008): 413-417.*

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