Systematic lateral and vertical manipulation of PTCDA on the Ag(111) surface for scanning quantum dot microscopy tip functionalization

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The manipulation of single molecules on metal surfaces has early been identified as a key approach for the development and construction of nanoscale structures. Recently, this approach gained significant interest for tip functionalization in refined scanning probe microscopy (SPM) methods such as scanning quantum dot microscopy (SQDM) [1]. SQDM enables the measurement of electrostatic potentials as well as magnetic fields at the atomic scale [2] and requires a tip terminated with a molecule acting as a quantum dot. Precise control of the molecular configuration at any time during the functionalization procedure is required to achieve such functionality.

Here, we use atomic force (AFM) and scanning tunneling microscopy (STM) methods at low temperature (5K) and under UHV conditions to investigate and control the lateral and vertical manipulation of single 3,4,9,10-perylenetetracarboxylic-dianhydride (PTCDA) molecules on the Ag(111) surface. We first present a strategic approach to systematically navigate through the systems vast parameter space for the lateral isolation of an individual molecule [3]. In particular, a specific bond to one of the PTCDA carboxylic oxygen atoms is employed as a handle to manipulate the molecule in a most controlled manner. Second, the isolated molecules are then lifted off the surface for tip-functionalization by utilizing a 3D haptic positioning control [4]. Last, the quantum-dot properties are tested for their sensing capability by measuring a SQDM signal. Our systematic protocol is expected to significantly improve the efficiency of both nanofabrication and tip functionalization.

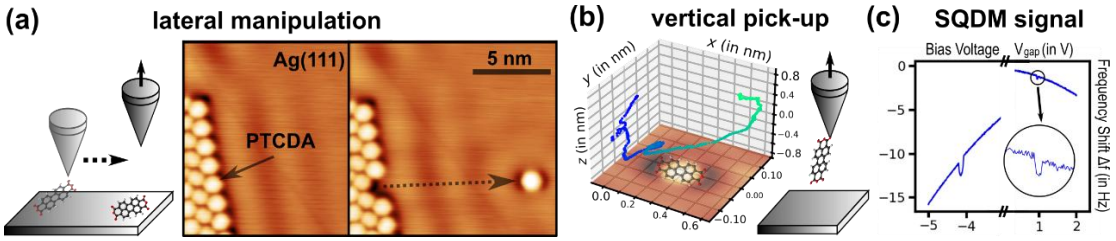

Figure 1. Conceptional strategy of (a) isolating an individual PTCDA molecule from a molecular island and (b) lifting it off the Ag(111) surface along a specific trajectory for functionalizing the SPM tip to support SQDM measurements. (c) SQDM signal.

References

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