

Surface gating for atomic scale dopant devices

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STM-based fabrication using hydrogen depassivation lithography fabrication of planar atomic-scale dopant profiles with extremely high density and abrupt interfaces. For quantum applications it is often required to be able to provide well-aligned micron scale support structures for atomically defined devices such as antennas (for coherent manipulation) and top gates (for efficient chemical potential control). In this talk we present a single electron quantum device with a central island and a set of two in-plane gates used to capacitively control the flow of current between source/drain-leads and the quantum dot island. We demonstrate successful integration of a low-thermal budget top gate using an e-beam grown HfO₂ dielectric layer while maintaining the functional integrity of the buried atomic device. Compared with the STM-patterned in-plane gates, we demonstrate expanded gating range and improved tunability of the STM-fabricated SET island tunnel-coupled few-dopant quantum dots using the top gate and find good agreement between the experimental results and capacitance simulations. We will discuss the potential applications of using a top gate to globally address scaled-up arrays of donor-dots as well as future directions of more complex top-gate designs. We will also present new advances in alignment strategies that improve back-end gate alignment to atomic-scale STM patterned devices.