Atomic Scale Fabrication and Application of Silicon Dangling Bonds

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A dangling bond (DB) on the surface of hydrogen-terminated silicon forms an atomic silicon quantum dot, which is capable of localizing up to two electrons. By exploiting their electronic properties, new circuits based upon precisely patterned DBs can enable future device architectures. Among these are atomic scale logic devices, which have been predicted to reduce power consumption by several orders of magnitude compared to conventional devices [1]. The fabrication of these devices requires the precise control over the placement of DBs to achieve proper functionality. Scanning Tunneling Microscopes (STMs) are employed to fabricate many of these devices and structures [2,3]. However, at the atomic scale fabrication presents unique challenges due to the extreme sensitivity to uncertainties in the STM tip position and geometry, even when working at cryogenic temperatures. These uncertainties can result in the creation of misplaced DBs during fabrication, and previously required the entire structure to be discarded. A reliable method to cap/erase individual DBs with single atoms of hydrogen via STM tip will be discussed, along with several new applications [3]. This newfound ability has greatly improved our fabrication yields, allowing for the creation of truly prefect DB structures. With these techniques, new experiments and applications are now within reach, including ultra-high density, room-temperature stable memory, and rudimentary sensing.

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