Dangling Bond Logic: Designing Boolean logic gates on a Si(100)-H surface.

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As the semiconductor industry races towards the atomic scale, it becomes imperative to investigate how many atoms are required to fabricate functional devices. The controlled desorption of hydrogen atoms from the hydrogen-terminated Si(100)-(2x1)-H surface with the Scanning Tunneling Microscope tip creates surface dangling bonds, which introduce states in the Si(100)-(2x1)-H surface band gap [1]. These surface dangling-bond states can be coupled and manipulated to construct atomic-scale logic devices.

In this presentation, the design of dangling-bond Boolean logic gates with two inputs and one output on a Si(100)-(2x1)-H surface will be illustrated [2-4]. The Dangling Bond Logic gates are connected to the macroscopic scale by metallic nano-pads physisorbed on the Si(100)-(2x1)-H surface. The logic inputs are provided by saturating and unsaturating surface Si dangling bonds, which can, for example, be achieved by adding and extracting two hydrogen atoms per input. Quantum circuit design rules and quantum transport calculations are used to investigate the operation of the proposed Dangling Bond Logic gates, interconnected to the metallic nano-pads by surface atomic-scale wires. The calculations demonstrate that the proposed logic devices can reach ON/OFF ratios up to 2000.

References

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