

Toward Atom Scale Ultra Low Power Classical Circuitry and Quantum Circuitry

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Decades of academic study of silicon with scanned probe and related techniques have made it possible to now envisage a silicon-based, atom-scale, ultra-low power circuitry that merges with and enhances CMOS electronics technology.

A key step was made in 2008 when single silicon dangling bonds on an otherwise H-terminated surface were shown to behave as ultimate small quantum dots [1]. Because all such dots are identical, and spacing between dots can be identical, and dots can be placed very closely to achieve strong interaction, and because many, many dots can be printed easily there appears to be prospects for interesting circuitry. The same dots can be deployed to make “passive” elements like wires and to make active elements of diverse kinds including quantum cellular automata with the prospect of room temperature operation, and single electron transistors (SETs) of extremely narrow device to device variation.

After a quarter century stasis, a flood of new insights into atom scale properties of silicon has emerged. Among the new results I will describe are; single-electron, single-atom transport dynamics [2], new dangling bond (DB) charge state spectroscopy [3], time-resolved single dopant charge dynamics [4], time-resolved imaging of negative differential resistance on the atomic scale [5] and chemical bond contrast in AFM images of a hydrogen terminated silicon surface [6].

References

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