

Designing all simple logic gates and half-adder circuit on a Si(100)–H surface

Omid Faizy Namarvar,¹ Ghassen Dridi,¹ and Christian Joachim^{1,2}

¹ *CEMES-CNRS, 29 rue J. Marvig, 31055 Toulouse Cedex, France ;*

² *WPI-MANA, National Institute for Material Sciences, 1-1 Namiki, Tsukuba, Ibaraki, Japan .*

Belonging to the Quantum Hamiltonian Computing (QHC) branch of quantum control [1-2], atomic-scale Boolean logic gates (LGs) with two inputs - one output (OR, NOR, AND, NAND, XOR, NXOR) and - two outputs (half-adder circuit) were designed on a Si(100)-(2×1)–H surface following the experimental realization of a QHC NOR gate [3] and the formal design of an half adder with 6 quantum states in the calculating block [4]. The logical inputs are determined by two nearest neighbor crossing surface Si dangling bonds, which can be, for example, activated by adding or extracting two hydrogen atoms per input. QHC circuit design rules together with semi-empirical full valence K-ESQC transport calculations were used to determine the output current intensity of the designed LGs when interconnected to the metallic nano-pads by surface atomic-scale wires. Our calculations demonstrate that the proposed devices can reach a “0” to “1” logical output ratio up to 10 000 for a running current in the 0.2 μ A range for 50 mV to 150 mV bias voltage around the nano-pads Fermi level.

References:

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