

Design and simulation of two bits single-electron logic circuit using double quantum dot single electron transistor

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Abstrak

Electrons in a single electron transistor (SET) are transported one by one from source to drain based on the coulomb blockade mechanism. The transport rate is sensitively influenced by the presence of event a single electron charge located near the quantum dot. Based on this characteristic, we propose a Double Quantum Dot (DQD) SET to manipulate the presence of an electron in Quantum Dot (QD) as an implementation of a single-electron logic concept. The existence of an electron in the QD is used to represent logic 0 (no electron in QD) or logic 1 (an electron in QD). The logic states are sensed by a SET charge detector. Design of circuit based on DQD and SET charge detector are simulated by using SIMON 2.0 software. From the simulation, we have successfully developed a two-bit logic circuit by controlling the presence of an electron in DQD. We found that the existence of an electron in QD can be controlled by application of a gate voltage larger than $190\mu\text{V}$. Gate should be separated from QD by a non-tunnel capacitor of 500 aF. No larger than 1 aF of interdot tunnel capacitance is required to isolate the QD from one to another. The existence of an electron in QD is successfully detected by SET based charge detector.