Study of tunneling currents through germanium quantum-dot single-hole and –electron transistors

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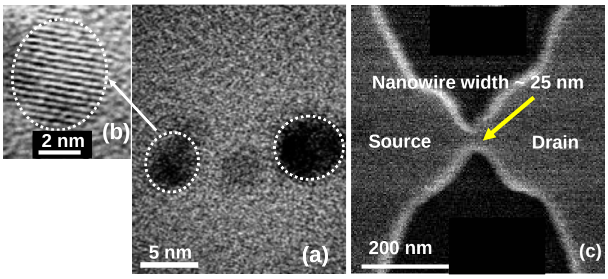
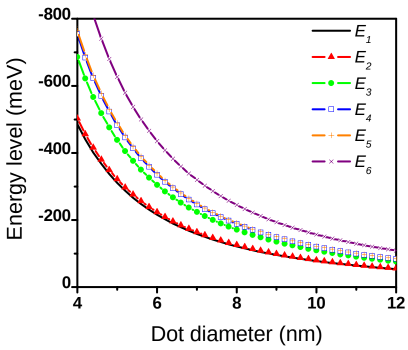
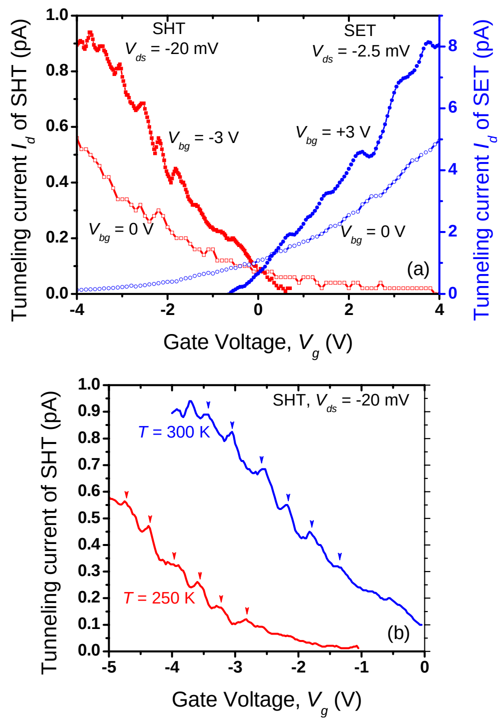
The transport properties of Ge quantum-dot (QD) single-hole and -electron transistors (SHTs/SETs) are experimentally investigated. The tunneling currents of Ge-SETs and -SHTs could be modulated by adjusting top Si layer thickness on silicon-on-insulator substrates or applying back-gate biases due to parasitic transistors effect. The Coulomb oscillation of tunneling current is stable with respect to temperature, indicating the observed current should go through the energy levels of a Ge QD but not through trap states. The $k \cdot p$ method has been employed to calculate the hole energy levels of a spherical Ge QD to clarify the homogeneous oscillation current characteristic of SHTs.



(a) Cross-sectional TEM images of a thermally oxidized $Si_{0.95}Ge_{0.05}$/Si-on- insulator structure at 900 ^{o}C, (b) enlarged TEM image of a Ge QD, and (c) plane-view SEM micrograph of a nanowire connecting source/drain electrodes.



The six lowest hole energy levels of a Ge QD are calculated with a spherical model in the framework of the $k \cdot p$ theory.



(a) Tunneling currents of a Ge-SHT and SET as a function of gate voltage at 300 K with different back-gate voltages. (b) Tunneling currents of a Ge-SHT as a function of V_g at 300 K and 250 K, respectively.

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