Muli-state operation in quantum dot channel FETs incorporating spatial wavefunction-switching

F. JAIN, K. BASKAR, S. KARMAKAR, P-Y. CHAN, E. SUAREZ, B. MILLER, J. CHANDY, University of Connecticut, E. HELLER, RSoft Design Group — Three-state behavior has been demonstrated in Si and InGaAs quantum dot gate (QDG) field-effect transistors (FETs). Recently, spatial wavefunction switched (SWS) and quantum dot channel (QDC) FETs have been reported to exhibit four-state operation. This paper presents simulations of versatile combinations of SWS features in QDC channels to optimally design multi-state transport in FETs that have the potential of scaling to sub-12nm regime. A QDC-FET channel is modeled as having superlattice-like mini-energy bands where the carrier wavefunctions are transferred across the channel as drain voltage is changed, producing step-like multi-state electrical characteristics. This behavior is analogous to that of single electron transistors. The difference is that QDC devices use more than a few electrons and operate at room temperature. The SWS feature additionally provides carrier transfer from lower to upper dot layer(s) in a QDC having more than one layer of quantum dots.

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4Ibid.