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Theoretical Study of Multiple-Trap Correlations in Random Telegraph Signals of a Carbon Nanotube Field-Effect Transistor SMITHA VASUDEVAN, University of Virginia, JACK CHAN, BRIAN BURKE, KENNETH EVANS, KAMIL WALCZAK, MINGGUO LIU, JOE CAMPBELL, KEITH WILLIAMS, AVIK GHOSH — We develop a theoretical model to explain the observation of high amplitude, multiple-trap random telegraph signatures (RTS) in the electronic transport of a one-dimensional field effect transistor (FET) with a carbon nanotube channel. A unique RTS pattern is observed, with an initial strong blockade of the current that continues over a well-defined bias window, and subsequent reversal of the blockade through a separate RTS series. We ascribe our observations to correlated electrostatic effects between multiple charge traps along the channel, whereby one trap 'passivates' the other purely electrostatically and without any direct chemical bond. We present a robust quantum transport model that provides quantitative validation of this hypothesis. We assert that this effect, which has not been reported in bulk silicon devices, arises from the logarithmic electrostatic potential profile of the 1-D channel that allows the trap levels to slip past each other under the action of a remote gate, ultimately reversing their energy hierarchy and annihilating each other. Our results suggest that multiple-trap behavior in low-dimensional field-effect devices may be adaptable for several new transistor and sensor technologies.

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