Representation of Improved Structures of Tunnel Field Effect Transistors using Electrically Doped and Junction-less in Analog and Digital Applications and Comparative Analyzing.

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Tunnel transistors due to having lower off-state current and steeper subthreshold slope than metal-oxide-semiconductor transistor have been considered. The drawbacks of the performance of TFETs are the inferior on-state current and ambipolar behavior. Another drawback in the down-scaling process of transistors is to fabricate metallurgical junctions (source/channel and drain/channel) due to the need for the creation of abrupt junctions. This problem can be solved using junctionless transistors. In this study, in order to increase the on-state current in electrically doped silicon Tunnel FET (base device), GaSb with low band gap instead of silicon is employed. Then to reduce the off-state and ambipolar-state current, Gaussian doping instead of uniform doping is applied to channel and source regions. In this way, the threshold voltage, subthreshold swing, tranceconductance, and cut-off frequency are also improved. In the process of improving the device performance in analog and digital applications, the heterostructure channel/source interface is used in GaSb is allocated to the source and AlGaSb to the drain and channel regions. The optimal Al composition is also obtained respect to the trade-off between electrical characteristic parameters. By applying Gaussian doping in the above structure, ambipolar current remarkably decrease by 39% compared to the base device. In the following, a new structure of an electrically doped N-type silicon Tunnel FET using P substrate is represented. Furthermore, Ge with a narrow band gap is used as the source material and GaAs as the channel and drain materials to realize a heterostructure channel/source interface which improves on-state current, threshold voltage, and

subthreshold swing by 43%, 60%, and 44%, respectively compared to the represented device. In order to suppress ambipolar current, a metal is implanted in the gate oxide at the drain/ channel junction which increases the tunnel barrier width at this junction and consequently reduces significantly the ambipolar-state current by 65%. In the end, the behavior of this device is trained to a perceptron artificial neural network. In the final section of this essay, In order to suppress ambipolar current of a junctionless tunnel FET (JLTFET), this study focuses on the effect of the gate metal on the drain semiconductor which was modeled as a capacitor by the analytical survey. The capacitance behavior and, consequently, the electric field and the energy band diagram vary with respect to the material of the capacitor’s dielectric. It is found that using hfo2 as the oxide pocket over the drain leads to decrease the ambipolar and off- states current. Then to enhance the electrical characteristics of the device in analog applications, a heterostructure channel/source interface, and hetero dielectric structure are applied which leads to an increase in on-state current and a decrease in the subthreshold swing by 57% and 78% respectively compared to the base JLTFET. The electrical characteristics are all derived 2D ATLAS device simulator.

Keywords : Band to Band Tunneling, Electrically doped, Heterostructure, Gaussian doping, Metal implant, Attificial neural network