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Steep Subthreshold Slope Characteristics of Body Tied to Gate NMOSFET in Partially Depleted SOI

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***Abstract*:** A new body tied to gate (BTG) n-channel metal-oxide-semiconductor field-effect-transistor (NMOSFET) with a diode in partially depleted SOI (PD SOI) is proposed and investigated. We first compare the transfer and output characteristics between the regular and BTG NMOSFETs with grounded body and floating body. The steep subthreshold slope (<6 mV/dec) and low OFF current (~0.01 pA/um) of the BTG NMOSFET with floating body are observed at V_D = 3.3 V. Mechanisms of the floating body effect (FBE) and the diode are analyzed to explain the outstanding performance. The hysteresis characteristics of BTG NMOSFETs are also presented in comparison to regular ones. Finally, the steep subthreshold characteristics of the BTG NMOSFET with floating body at low drain voltage are studied for ultralow power application.

***Keywords*:** Diode; floating body effect; parasitic bipolar transistor; Partially Depleted SOI; subthreshold slope.

1. Introduction

Metal-oxide-semiconductor field-effect transistor (MOSFET) scaling has enabled extraordinary improvements in the switching speed, density and cost. However, the supply voltage (V_{DD}) scaling has been slow due to non-scalability of the subthreshold slope (SS) and OFF current (I_{OFF}). The SS is fundamentally limited to be no less than 60 mV/dec at room temperature. To circumvent this limit, alternative device designs have been proposed and demonstrated. These include the impact ionization