Performance analysis of MoS_2 based Ferroelectric Tunnel FET

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Abstract:
The term "Boltzmann tyranny" characterizes the inherent thermionic constraint on the subthreshold slope (SS) of a conventional field-effect transistor. Thereby hindering the reduction of the supply voltage and, consequently, impeding efforts to minimize overall power consumption [1, 2]. In this study, we demonstrate the realization of steep-slope MoS_2 based negative capacitance-tunnel field effect transistor (NC-TMDTFET) through the incorporation of ferroelectric layer (silicon doped HfO_2) into the gate stack. The proposed device exhibits a remarkable performance parameter because of the presence of the NC effect. The transfer characteristics of the proposed device are illustrated in Fig. 1(b) for both forward sweep (FS) and reverse sweep (RS). The FS demonstrates I_{ON} of 1.57x10$^{-4}A/\mu m$, I_{OFF} of 9.05x10$^{-17}A/\mu m$, I_{ON}/I_{OFF} of 10^{13} and SS of 32 mV/decade. In the RS, I_{ON} is observed to be 2.63x10^{-4} $A/\mu m$, I_{OFF} to be 3.39x10$^{-17}A/\mu m$, yielding an I_{ON}/I_{OFF} of 10^{12}, with a corresponding SS of 18 mV/decade. Transfer characteristics and corresponding SS and I_{ON}/I_{OFF} of the device is shown for inclusion of different thickness of Fe layer. An increased Fe layer increase in ON current of the device due to amplification of internal gate voltage because of the negative capacitance effect.

References

[1] D. J. Frank et al., Proc. IEEE, vol. 89, 259–288, (2001)
[2] K. Boucart et al., IEEE Trans. Electron Devices, vol. 54, pp. 1725–1733, (2007).

Figures

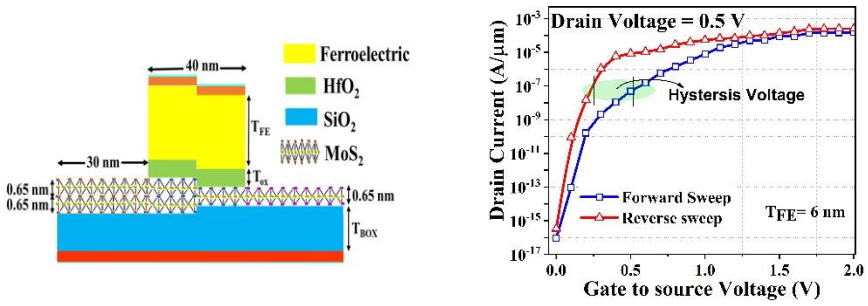

Figure 1: Schematic of the proposed NC-TMDTFET, and transfer characteristics in both FS and RS of NC-TMDTFET for TFE = $6nm$.

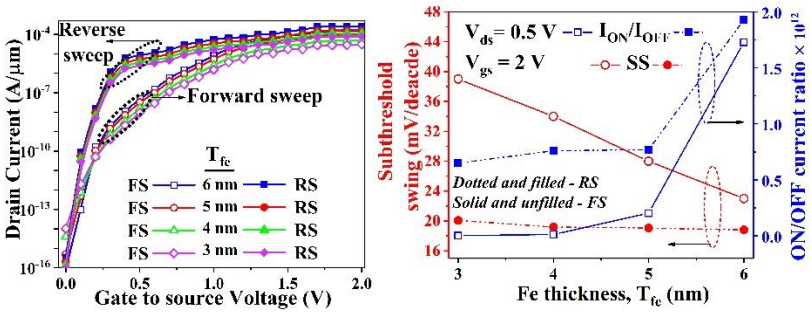

Figure 2: Transfer characteristics and SS and I_{ON}/I_{OFF} in both FS and RS of NC-TMDTFET for variation of different Fe thickness.