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Steep subthreshold-swing InGaAs FETs Using Ferroelectric Materials

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Abstract

Since the ultra-scaled MOSFET devices are reaching their fundamental physical limitation of the k_BT/q subthreshold swing (SS), the negative capacitance (NC) concept has emerged as one of promising solutions to overcome the Boltzmann tyranny. The NC effect has been realized by using various ferroelectric (FE) materials in the gate dielectric of the transistors. Among many FE materials, $HfZrO_x$ (HZO) thin films deposited by ALD have been introduced in both planar and non-planar NC FETs with SS below 60 mV/dec at room temperature. Steep SS properties are reported on Si, Ge, and GeSn FETs featuring FE HZO gate stack for the future lower voltage FET operations. InGaAs materials, owing to its extremely high carrier transport properties, have been widely investigated as the alternative channel materials in the electronic devices. However, not much study has been done on the demonstration of NC effect on InGaAs MOSFETs. A high density of interface trap states in the InGaAs MOS structures can be the root, prohibiting the NC behaviors to be achieved in the MOSFETs. In this article, the electrical properties of NC InGaAs MOSFETs with different HZO thicknesses are studied. Moreover, for the first time, the NC InGaAs FinFETs with sub-k_BT/q SS are fabricated and characterized.