Enhanced reliability of vertical strained impact ionization MOSFET incorporating dielectric pocket for ultra-sensitive biosensor applications

Abstract

Fast switching with an enhanced reliability device structure of Vertical Strained Impact Ionization MOSFET incorporating Dielectric Pocket (VESIMOS-DP) has been successfully design, simulated and analyzed in this paper. Ultra-low power with low subthreshold swing (*S*) and high breakdown voltage are imperative for ultra-sensitive biosensors. Impact ionization MOSFET (IMOS) is predicted to be capable of *S* as low as 20 mV/dec, which is much lower than Conventional MOSFET (CMOS). There are significant drop in subthreshold slope (*S*) while threshold voltage is increase as the body doping concentration increases. *S* value for DP place at source side is higher (*S* 24.4 mV/decade) as compared at the drain side (*S* 18.9 mV/decade) intrinsic region. The vicinity of DP near the drain region reduces charge sharing effects associated with the source and thus improves impact ionization rate. The introduction of a Dielectric Pocket (DP) is believed to be able to minimize the PBT effect while improving the reliability of the device by attaining higher breakdown voltage. Consequently, with the reduced of alloy scattering, the electron mobility has been improved by 22%. In many aspects, it is revealed that the incorporation of DP enhanced the reliability of VESIMOS for future development of nanoelectronic devices.