

Enhanced performance analysis of vertical strained-sige impact ionization MOSFET (VESIMOS)

Abstract

The Vertical Strained Silicon Germanium (SiGe) Impact Ionization MOSFET (VESIMOS) has been successfully developed and analyzed in this paper. VESIMOS device integrates vertical structure concept of Impact Ionization MOSFET (IMOS) and strained technology. The transfer characteristics of VESIMOS revealed an inverse proportionality of supply voltage, V_D and sub-threshold, S due to lower breakdown strength of Ge content. However, the S is in direct proportion to the leakage current. The $S=10\text{mV/dec}$ was successfully obtained at threshold voltage, $V_T=0.9\text{V}$, with $V_D=1.75\text{V}$. This V_T is 40% lower than V_T for Si-vertical IMOS. The output characteristics goes into saturation for V_D more than 2.5V , attributed to the presence of Ge that has high and symmetric impact ionization rates. Electron mobility was improved by 40% compared to Si-vertical IMOS and an increase in strain will also increase mobility and reduce further the V_T . However, the increase in strain layer thickness, T_{SiGe} , resulted in an increase of V_T and lowered the mobility. This is due to the strain relaxation in the SiGe layer. Finally, at high source-drain doping concentration, $N_{S/D}=2 \times 10^{18}/\text{cm}^3$, the V_T dropped to 0.88V , with V_D of 1.75V . This is due to high electric field effect in the channel at high doping concentration, which is contrary to the doping effects of conventional MOSFET.