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Current voltage characterization of high-*k* oxide on InGaAs substrate

The aggressive down scaling of complementary metal oxide semiconductor (CMOS) has reduced the thickness of SiO_2 below the 14 Å. The high gate leakage current through ultra-thin oxide increases exponentially due to direct tunneling of carriers. The high leakage current results in power dissipation due to which reliability of oxide decreases. In order to address the down scaling for number of years and to reduce the power consumption, higher permittivity material such as Al_2O_3 & HfO_2 were used together with compound a semiconductor. The InGaAs has small effective mass as compared to Si, Ge and GaAs which leads to high electron mobility. The high-k films Al_2O_3 & HfO_2 were grown on an InGaAs substrate followed by metallization. The processed structure of sample is schematically shown in Fig. (1).

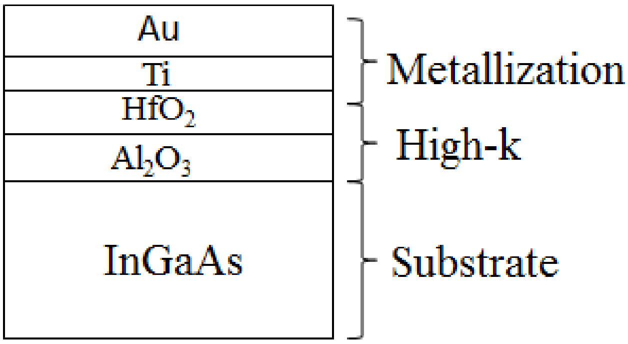

Figure 1: *Structure of MOS capacitor, n-type InGaAs was epitaxially grown on the InP substrate, high-k films by atomic layer deposition and metallization by evaporator.*

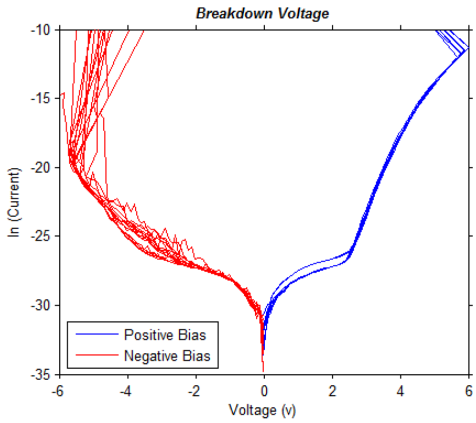

Figure 2: *Breakdown voltage under positive and negative applied bias*

High-*k* gate stack Al_2O_3/HfO_2 on InGaAs substrate was characterized to investigate the conduction mechanism, stress induced leakage current and soft & hard breakdown. The analyzed conduction mechanism through high-*k* oxide showed the thermal dependence at high temperature but experimental data were not fitted with PF-model neither with Schottky model. However, band to band tunneling was observed at lower temperature (0 $^{\circ}$C). The stress induced leakage current (SILC) was measured at 4.5 V constant voltage stress with periodic interruption (0 V - 3 V) to observe the damage across oxide. Time to breakdown 6.13×10^2 s was measured at 4.5 V constant voltage stress. Ramped voltage stress was used to measure breakdown across oxide. In Fig (2), 5.87 V and 5.22 V represent breakdown voltages under the positive and negative applied bias, respectively.

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