DC AND SMALL SIGNAL DEGRADATION IN INAS - ALSB HEMTS UNDER HOT CARRIER STRESS

By

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ABSTRACT

Indium Arsenide (InAs) channel High Electron Mobility Transistors (HEMTs) with Aluminium Antimonide (AlSb) barriers are an exciting option for low power RF applications due to excellent quantum well confinement and very high low-field electron mobility. The fundamental degradation trends and mechanisms for the device are yet to be adequately understood. In this thesis, a detailed analysis of DC and RF degradation under hot carrier stress is presented.

Based on electrical stress performed on devices with varied starting characteristics, we show that some devices are severely degradation prone in operating conditions where the electric field in the Indium Arsenide channel and the impact ionization rate are simultaneously high. Annealing results, coupled with device simulations and Density Functional Theory (DFT) calculations, show trends consistent with an oxygen-induced metastable defect in AlSb dominating the device degradation. Some physically abundant impurities like Carbon and Tellurium are shown to be unlikely candidates for producing the observed degradation.

When stressed with hot carriers or under high impact ionization conditions, the majority of the devices show negligible change in DC characteristics, but appreciable degradation in peak f_T. Short access region lengths exacerbate the degradation, which can be traced to a reduction in peak RF g_m, resulting either from reduced hole mobility or a stress-induced increase in thermodynamic relaxation time of electrons in the channel. Increase in parasitic capacitances after stress is shown to have a secondary contribution to the degradation in devices with long access regions. For devices with short access regions – a

post-stress increase in gate to source parasitic capacitance (C_{gs}) significantly adds to degradation caused by reduction in peak RF g_{m}.

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