

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

By

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Dissertation

Submitted to the Faculty of the
Graduate School of Vanderbilt University
in partial fulfillment of the requirements

for the Degree of

DOCTOR OF PHILOSOPHY

in

Electrical Engineering

December, 2010

Nashville, Tennessee

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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 .

ACKNOWLEDGEMENTS

It is my pleasure to thank the people responsible for providing me the strength to take this document to its completion. I am grateful to my advisor, Professor Robert Reed for standing strongly by my decision to pursue a topic for which results were uncertain. I thank him for his patience and encouragement when results were hard to come by. I thank Professor Daniel Fleetwood for his useful inputs, reality checks, support and encouragement. I acknowledge the critically important role of Professor Sokrates Pantelides in giving a major part of this work its final shape.

During the course of this work – the person I have turned to most often for advice and ideas is Professor Ronald Schrimpf, who taught me with EECE 306 virtually everything I know about semiconductor devices to this date. I thank him for equipping me years in advance with almost all the concepts useful and applicable to my PhD research problems. These will remain assets going into professional life as a microelectronics engineer - as will Professor Norman Tolk's outstanding lessons on condensed matter physics.

It has been my pleasure and good fortune to have Xiao Shen as a colleague. His inputs to this work were crucial. But more importantly – he was one of the few people who made significant additions to my conceptual clarity on some very basic questions of behavior of defects in a semiconductor.

A major section of this work was made possible by the extraordinary help and professional courtesy of Jonathan Felbinger of Cornell University. I cannot thank Jonathan and Professor Lester Eastman enough for the opportunity they provided me to gain some experience of a very useful experimental and analytical technique.

My sincerest thanks go to Dr. Berinder Brar and Dr. Joshua Bergman of Teledyne Scientific – who ensured that this work could get started in the first place. Two years ago when I requested them to help me obtain some devices – any response at all would have been a positive development. Instead, there was extraordinary generosity and prompt action from two of the most renowned researchers in Indium Arsenide electronics to help out a graduate student they didn't even know.

Finally – I want to mention the people who made life – half the globe away from family and many good friends a little less lonely. From Naushad and Himangshu Dutta's haunting melodies to the vibrant rendition of the little known singer on the internet, from Kabir Suman's lyric to Chandrabindoo's wonderful frivolity and Dipangshu's rhyme, from Srikanth's wisecracks and Jugantor's banter to Aritra's clever wordplay, from Groucho Marx and Monty Python to Tulsi Chakraborty, from the cricket loving cab driver of Nashville to the wonderful people at the food counter or behind the cash registers of Medical Center cafeteria – a hundred people have taught me more than the most instructively written book chapters. I owe them my sincerest gratitude for often reminding me that no matter how many mistakes and wrong choices I make – there is always life, humor, music – and a new day to come home to.

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