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TOPIC:

III-Nitride HEMTs and MIS-HEMTs – A Study on Gate Leakage and Threshold Voltage Shift

ABSTRACT:

GaN-based High Electron Mobility Transistors (HEMTs) have emerged as an attractive choice for high power RF applications. However, despite extensive research over the last two decades, the gate leakage mechanisms and the ways to suppress the same in these devices is still not well understood. In this talk, a detailed analysis of the leakage mechanisms in both AlGaN/GaN and AlInN/GaN HEMTs over a wide range of temperature and bias along with a comprehensive model to describe the gate leakage mechanism will be presented.

To reduce the gate leakage in HEMTs, a dielectric layer is used over the gate resulting in MIS-HEMT structure. It is also predicted that a positive shift in threshold voltage (V_{Th}) is possible if a charge free dielectric is deposited on AlN/GaN HEMT and a normally off device may be achieved if the dielectric thickness is sufficiently large. However, a large positive fixed oxide charge (Q_f) has generally been reported for Atomic Layer Deposited (ALD)-Al_2O_3/III-N interface, resulting in a large negative shift of V_{Th}. Interestingly, in our ongoing work on AlInN/GaN MIS-HEMTs using Reactive-Ion-Sputtered (RIS) Al_2O_3 as gate insulator, a positive shift in V_{Th} is observed. These devices also exhibit low I_G, low C-V hysteresis and high extrinsic transconductance (g_m) demonstrating the suitability of RIS Al_2O_3 as gate dielectric. These aspects will also be presented in the talk.

PROFILE:

Nandita DasGupta received the B.E. degree in Electronics and Telecommunication Engineering from Jadavpur University, Kolkata, India in 1982, M. Tech. in Electrical Engineering and Ph. D. degrees from IIT Madras in 1984 and 1988 respectively. She was awarded Alexander von Humboldt Fellowship in 1991 and spent one year in Technische Hochschule Darmstadt, Germany. Since 1993, she has been a Faculty member in the Department of Electrical Engineering, IIT Madras and is currently a Professor. Her

research interest is in the area of Semiconductor Device Technology and Modeling as well as Micro-Electro-Mechanical Systems (MEMS) and photonics. She has more than one hundred research publications in International Journals and Proceedings of International Conferences and has co-authored a book titled "Semiconductor Devices – Modeling & Technology". She has also developed a 40 hour video course on "VLSI Technology" for the web-based NPTEL program. She is one of the Principal investigators of DEiTY-sponsored Centre for NEMS and Nanophotonics at IIT Madras. She was awarded the MRSI Medal in 2014 for her contribution to Materials Science and Engineering.