MAR05-2004-010139

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

Dispersion in AlGaN/GaN HEMTs

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Gallium nitride high electron mobility transistors (HEMTs) are living up to their potential as the high power high frequency transistor of the future. The record power density at 4 GHz now exceeds 30 W/mm [1], which is more than an order of magnitude greater than GaAs-based transistors. Achieving this record performance required controlling the phenomena known as "dispersion" in AlGaN/GaN HEMTs. Dispersion is the term used to indicate that the dynamic characteristics of a device are different from the static characteristics. The two sources of dispersion are trapped charge and self-heating [2]. Although electron trapping can occur in many parts of the device, the surface has been identified as one of the dominant sources of dispersion in AlGaN/GaN HEMTs. At frequencies below Ka-band, a combination of surface passivation (typically SiN) and a field plate structure can be used to control dispersion. As the frequency of operation is pushed above 30GHz, the penalty paid in capacitance introduced by field plates prevents field plate structures from being used. In addition, as the gate length is decreased in order to increase the operating frequency, the peak electric field in the channel increases causing dispersion to increase and reliability to decrease. Understanding and controlling dispersion is the key for obtaining good power performance and reliability in AlGaN/GaN HEMTs. This talk will explain dispersion from the virtual gate model of the surface. Two primary methods for measuring dispersion (pulsed I(V) and RF I(V)) will be shown. Finally, data showing how dispersion affects reliability of AlGaN/GaN HEMTs will be given. [1] Y.-F. Wu, et al., IEEE Electron Device Lett., vol. 25, no. 3, pp. 117-119, March 2004. [2] P. H. Ladbrooke et al., Electron. Lett., vol. 31, no. 21, pp. 1875-1876, Oct. 1995.