Nitride Based Insulated Gate Field Effect Transistors

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In early nineties, Khan et al. and Binari et al. fabricate GaN-based Metal Insulator Field Effect Transistors (MISFETs) using i-GaN [1], i- AlGaN/GaN [2] and Si_3N_4 [3] as the gate insulator. More recently, Khan et al. demonstrated novel AlGaN/GaN Metal-Oxide-Semiconductor Heterostructure Field Effect Transistors (MOSHFETs) with superior performance on sapphire [4] and on SiC [5] substrates in 2000. Later on, the same group reported on Metal-Insulator-Semiconductor Heterostructure Field Effect Transistors (MISHFETs) using Si_3N_4 as the gate dielectric. The MOSHFET and MISHFET designs (see Figure 1) combines the advantages of having a large sheet electron density in the device channel the MOS structure, which suppresses the gate leakage current, and an AlGaN/GaN heterointerface that provides high density, high mobility two-dimensional (2D) electron gas channel. The latest improvements came from using the Strain Energy Band Engineering approach [6] and Pulsed Atomic Layer Epitaxy [7] to develop a Double Heterostructure Field Effect Transistor [8] and, finally, merging this novel concept with the insulating gate design to demonstrate MOS-DHFET [9] devices. In this talk, we review insulating gate III-FET technology[10] that holds promise for commercialization of GaN based electronics.

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