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The donor-acceptor relationship in HVPE GaN:Fe Substrates[1]
USTUN SUNAY, University of Alabama at Birmingham — GaN is a wide bandgap semiconductor plagued by a high concentration of residual donors, typically from unintentionally incorporated Si or O. The effect of these donors can be masked by doping with deep acceptors, such as Fe, which compensates the donors creating a semi-insulating material that can be used for RF applications. Compensation is thought to occur when the Fe^{3+} acceptor captures a donor electron, creating Fe^{2+} and a positively charged donor. Previously, an electron paramagnetic resonance (EPR) spectroscopy study of lightly Fe-doped ($1x10^{17}$ cm^{-3}) bulk GaN showed the existence of neutral donors and Fe^{3+} simultaneously. The presence of both calls into question the current understanding of compensation. To further understand donor-acceptor compensation, bulk GaN grown via hydride vapor epitaxy was intentionally codoped with Si donors and Fe acceptors in ratios ranging from 0.01 to 1.55. Both species were present in 3.5 K EPR spectra, but the Fe^{3+} acceptor signal decreased, and the neutral donor signal increased monotonically as the Si:Fe ratio increased. While this shows that Fe^{3+} partially compensates the neutral donor, interpretation of photo-EPR experiments suggests that some donors and acceptors are not interacting and that there is a multi-step mechanism for compensation. Cathodoluminescence (CL) results showed striated regions of luminescence intensity which indicate defect concentration non-uniformity. The leading explanation for the EPR and CL results is a physical separation between the donors and acceptors, leading to local variations in the Si:Fe ratio.

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Ustun Sunay
University of Alabama at Birmingham

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