InAlN/GaN Heterojunction: Prospects for Robust GaN Power Devices

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The intrinsic lattice-matched heterojunction of $In_{0.17}Al_{0.83}N$/GaN is capable of delivering record-level channel charge density and drive-current owing to the uniquely strong spontaneous polarization [1]. In addition, the elimination of stress in the InAlN barrier could lead to improved device reliability [2]. Such superior material properties of InAlN/GaN heterojunction favor the high-power switching applications. However, the breakdown voltage (BV) of InAlN/GaN HFETs, up to date, is limited by the severe gate leakage due to the indium segregation related dislocation [3], [4].

In this paper, we demonstrate a new Schottky-Contact technology to improve the off-state BV of the InAlN/GaN HFETs. Based on this concept, the Schottky-Source/Drain (SSD) and Schottky-Source (SS) InAlN/GaN HEMTs are proposed. The proposed devices with a L_{GD}=15 μm showed a BV more than 600 V, while conventional devices of the same geometry showed a maximum BV of 184 V. Without using any field-plate the BV of 650 V at drain leakage of 1 mA/mm was obtained in the SS HEMT with L_{GD}=15 μm, which is the highest BV ever achieved on an InAlN/GaN HEMT. The corresponding specific on-resistance ($R_{sp,on}$) is as low as 3.4 m$\Omega\cdot$cm^2. In order to further reduce the off-state leakage, a 12-nm high-k Al_2O_3 deposited by ALD was introduced as the gate dielectric in the SSD HEMTs, leading to the SSD MOSHFETs. The SSD MOSHFET with L_{GD}=10 μm achieves a BV of 460 V at drain leakage current as low as 10 μA/mm, realizing 170 % improvement in BV compared with the conventional Al_2O_3/InAlN/GaN MOSHFET. The improvement of the BV obtained in the proposed devices relies on the effective suppression of source carrier injection into the GaN buffer under the Schottky source due to the smooth metal morphology and elimination of metal spikes in the Schottky metallization.

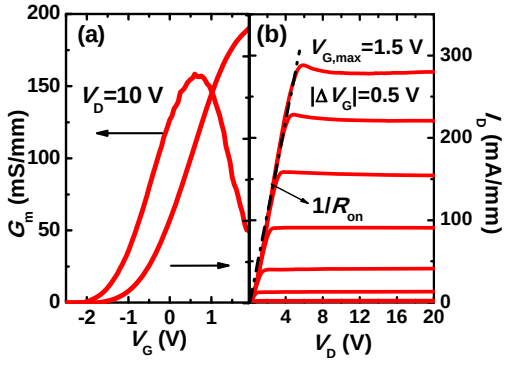

Figure 1. Measured *I-V* curves of the SS InAlN/GaN HEMT.

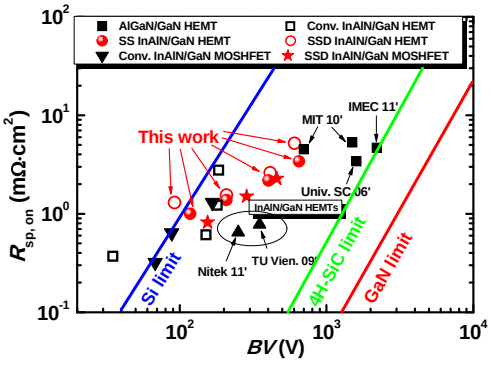

Figure 2. Comparison of $R_{sp,on}$-BV of proposed devices and reported results.

References

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