High voltage AlGaN/GaN Power HEMT for Power Electronics Applications

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AlGaN/GaN heterostructure is an attractive material for future switching power devices [1]-[2]. 600V AlGaN/GaN power HEMT was designed and fabricated using field plate structure for high voltage power electronics application such as power supplies and motor drives. The fabricated device is demonstrated in a DC-DC down converter circuit, showing the future possibility of high efficiency and high frequency operations of AlGaN/GaN power HEMTs.

For switching power device design, field plate structure is employed as shown in Fig. 1. Conductive SiC-substrate is chosen for backside field plate effect. Both the field plate over the gate electrode and the backside field plate effect with conductive substrate minimize the electric field peak at the gate edge and thus the high breakdown voltage of 600V has been obtained. The specific on-resistance was as low as 3.3 m□cm^2, which was 20 times lower than Si-limit and can be reduced by design optimazation (Fig. 2).

The fabricated devices was used for high voltage DC-DC down converter circuit demonstration. Fig. 3 shows the operating waveform under the input voltage of 200 V and the switching frequency of 200 kHz. The converter efficiency of 75% is obtained even at 500kHz switching with peak current density of 300A/cm^2. Since the switching loss can be reduced to a few % of the fabricated device by suppressing the parasitic capacitance, 600V class AlGaN/GaN power HEMT will be suitable for ultra low loss switching converters at high switching frequency over 1 MHz.

References:

[1] G. Shimin et al.: Electron Lett., vol. 36. pp. 2043, 2000.

[2] N. -Q. Zhang et al.: IEDM'01 Tech. Digest, pp. 589, 2001.

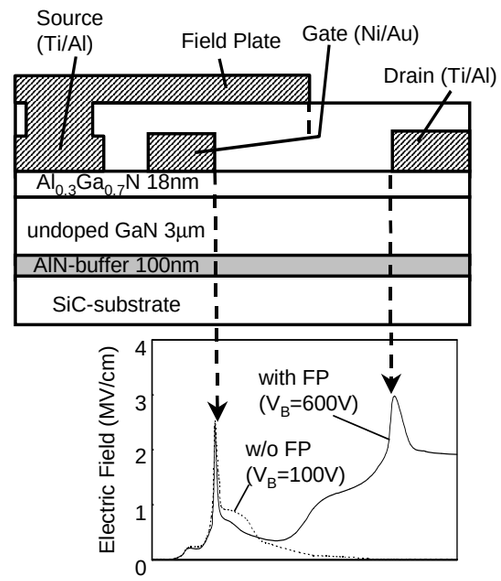

Fig. 1 Cross-sectional structures of fabricated AlGaN/GaN HEMT with field plate (FP) structure and electric field distribution along the interface of AlGaN layer with FP (solid line) and without FP (broken line).

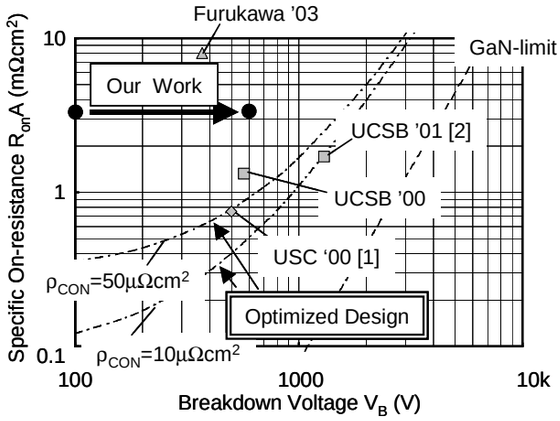

Fig. 2 Trade-off characteristics between specific on-resistance and breakdown voltage of AlGaN/GaN devices and theoretical GaN-limit.

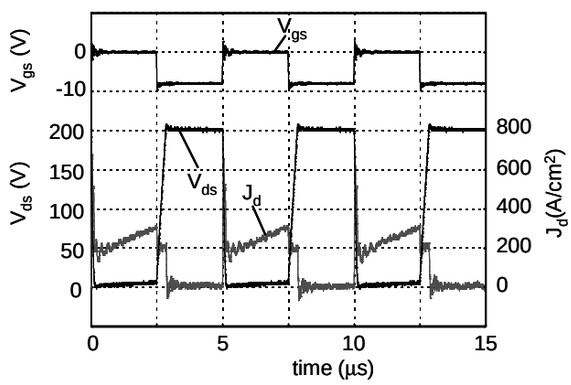

Fig. 3 Operating waveform for GaN power-HEMT in 200V-200kHz DC-DC converter application.