Kilovolt-class GaN HEMT with RESURF Structure

Wide-bandgap Gallium Nitride (GaN) power semiconductor devices have demonstrated a superior trade-off between high breakdown voltage, fast switching speed and small on-resistance as compared with Silicon (Si) and Silicon Carbide (SiC) counterparts. However, the current GaN high-electron-mobility transistors (HEMTs) are only commercialized in the low voltage realm below 650 V. The challenge for pursuing higher voltage in GaN HEMTs originates from the highly non-uniform electric field (E-field) distribution inside the device structure.

In this work, we explore the deployment of the reduced surface field (RESURF) structure to balance the net charge in the 2DEG channel and enable a uniform distribution of E-field, which would be particularly advantageous for voltage upscaling in GaN HEMT. The schematic of device structure and the optical microscopic image of the first-generation device are shown in Fig. 1 (a) and (b), respectively. This RESURF GaN HEMT device is built on our recent small-area device demonstration of high-voltage GaN HEMT up to 10 kV [1, 2], with the aim of advancing this device technology to higher technology readiness levels by fabricating ampere-class devices, packaging them, and evaluating them in inductive switching circuits. Fig. 2 shows the major characteristics of our small-area 10 kV RESURF GaN HEMT [1]. This project is performed in close collaboration with the industrial members in the consortium.

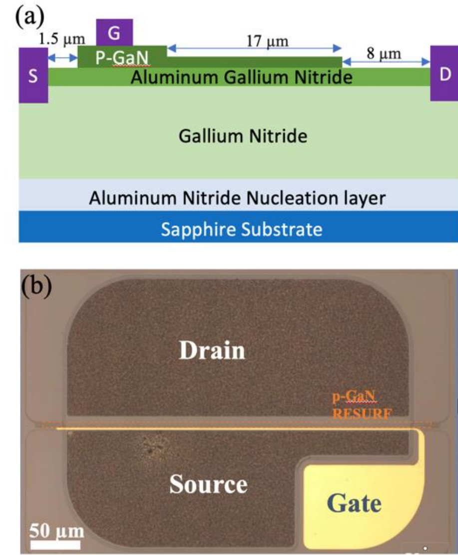

Fig. 1 (a) Example of the cross-section view of designed GaN HEMT with p-GaN RESURF structure (b) Optical microscopy image of the first-generation fabricated device

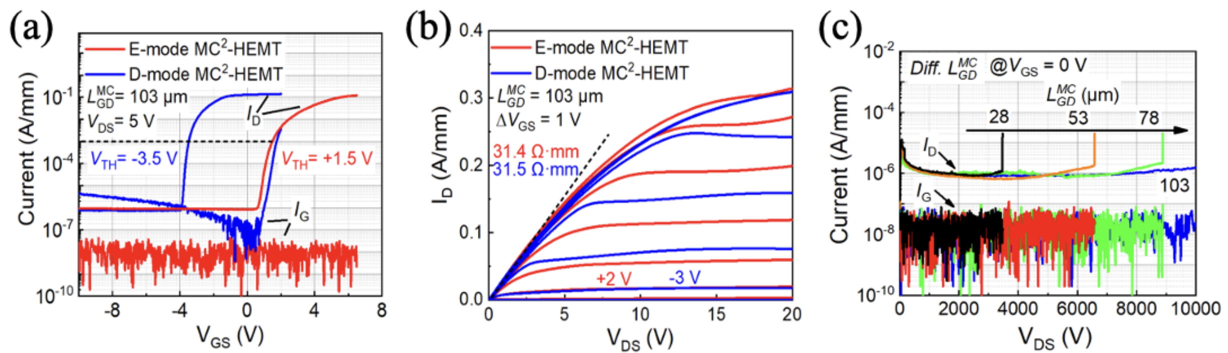

Fig. 2 Transfer (a) output (b) off-state IV characteristics (c) of p-GaN RESURF HEMT