

# Effect of High Temperature on Electron Trapping Behavior of GaN HEMTs on SiC Substrates with Field Plate

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High-electron-mobility transistors (HEMTs) based GaN are excellent candidates for the next-generation power-electronics. However, the dynamic performance of these devices is undermined as operation temperature increases. Due to existence of defects in GaN, electron trapping behavior induces dynamic  $R_{ON}$ -increase and current collapse at different working temperature. Therefore, it is important to understand the thermal effect of GaN HEMTs. In this work, we investigate the temperature-dependent trapping kinetics in the GaN HEMTs with a field plate on the SiC substrate. The dynamic measurements were carried out from room temperature to  $\sim 423\text{K}$ . The results exhibit that the value of  $R_{ON}$  and the shift of  $V_{th}$  is closely related with the temperature.

Figure 1 shows the variation of  $I_d$  with  $V_g$  ( $V_d = 6\text{V}$ ) of GaN HEMTs with a field plate length of  $1\text{ }\mu\text{m}$  at different temperature. In the pulse mode, the quiescent biases of gate and drain ( $V_{gq}$  and  $V_{dq}$ ) were set at  $-10\text{V}$  and  $40\text{V}$ , respectively. At room temperature (Figure 1 (a)), the values of the  $V_{th}$  were shifted toward the positive  $V_g$  by applying pulsed stress operation, and the  $\Delta V_{th}$  was estimated as  $0.25\text{V}$ . The  $V_{th}$  shift is attributed to carrier injection into the buffer layer under the gate region. The carrier is trapped in deep levels and causes the depletion of 2DEG in channel. Interestingly, when the temperature reached  $\sim 373\text{K}$ , the value of the  $V_{th}$  was independent on the bias stress and no change (Figure 1 (b)). The results are indicative that the electron injection and capture was confined at high temperature. And, it is probable that the depletion of 2DEG under the gate region was not changed by off-stress.

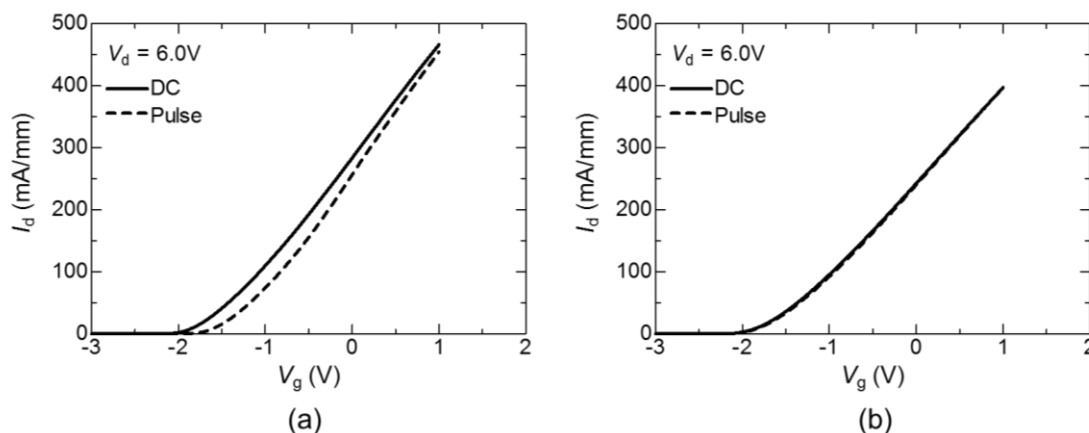


Figure 1  $I_d - V_g$  ( $V_d = 6\text{V}$ ) curve of GaN HEMTs with a field plate length of  $1\text{ }\mu\text{m}$  at different temperature: (a) 273K and (b) 373K.

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