5 - 18 Study of Single Event Burnout in GaN HEMTs Induced by Swift Heavy Ions

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The GaN-based power devices were irradiated with swift heavy ions (Xe and Bi) and under several test conditions. Experimental studies on the degradation of device electrical parameters under non-electrical stress and the leakage current and single event burnout effects of the power devices caused by the synergy of electrical stress and irradiation have been carried out, respectively. It was confirmed that the single event burnout related failure mode was excluded. The failure modes were discussed in terms of their failure mechanisms. Under the control of the high-voltage, the incident ions produced high-density carriers through ionization or excitation effect, thus a large current pulse is formed. The device power density increases sharply and the local temperature rises, while exceeding the melting point of the material, the "hot" burnout occurs, and results in a permanent damage[1].

As shown in Fig. 1, the performance of the device degraded more and more seriously with the increase in ion fluences without bias voltage during the irradiation. The device failed completely at a fluence of 1×10^{11} ions/cm^2. This indicates that the internal structure has been completely destroyed. With the increase in ion fluences, defects and defect clusters caused by the irradiation continue to accumulate in the 2DEG channel, resulting in structure disorders, changes in electrical parameters, and cause the degradation of the electrical properties of the device[2]. The latent tracks are generated in the devices without bias voltage during the irradiation process. The lattice disorders induced lead to a decrease in the concentration of the carrier and an increase in resistivity, which eventually causes the degradation of the electrical performance in the device, and even the performance failure occurred.

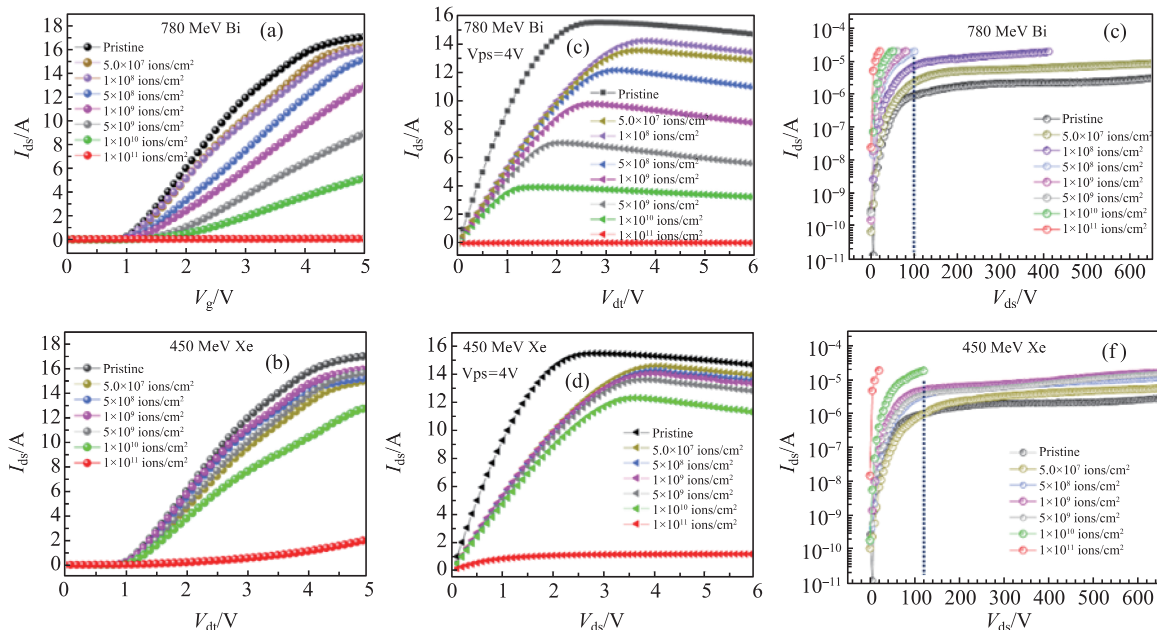

Fig. 1 (color online) (a)∼(b) Transfer characteristics, (c)∼(d) output characteristics and (e)∼(f) breakdown voltage of GaN FET before and after the irradiations.

References

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