Recessed-gate AlGaN/GaN High Electron Mobility Transistors (HEMTs) Prepared by Photo-electrochemical Etching and Post-metallization Annealing

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Up to the present, the device processing technology has been widely investigated on AlGaN/GaN HEMTs for the improvement of their performance and reliability. In this study, the low-damage photo-electrochemical (PEC) process was optimized for the formation of recessed-gate AlGaN/GaN HEMTs. Furthermore, the effect of the post-metallization-annealing (PMA) process was investigated for the improvement of gate controllability.

AlGaN/GaN heterostructure grown on SiC substrate is used as the starting wafer, as shown in **Fig. 1**. The PEC etching was conducted in the acid-based electrolyte for the formation of recessed-gate structure [1]. After the formation of the gate electrode, PMA was carried out at 300˚C in N_2 atmosphere. In addition to the electrical measurements, the observation of electro-luminescence (EL) was conducted from the backside of devices.

Strong correlation was observed between gate leakage currents and EL intensity, as shown **Figs. 2(a)-(e)**. The leakage currents of planar-gate HEMT, which was formed as a reference, was decreased after the PMA. Before the PMA, localized EL spots were observed at the edge of gate electrode by applying V_{DS} = 30 V, and then the device was broken. However, after the PMA, uniform EL was observed along the edge of gate electrode even at V_{DS} = 40 V. As for the recessed-gate HEMT, the gate leakage currents and the EL intensity were further decreased as compared to those of planar-gate HEMT. These results suggest that the combination of PEC and PMA processes is promising for the improvement of electrical properties of AlGaN/GaN HEMTs.

Acknowledgements: I would like to thank Mr. H. Fukushima for assistance with the emission-microscope observation. This work was carried out by the joint usage / research program of the Institute of Materials and Systems for Sustainability (IMaSS), Nagoya University and by JSPS KAKENHI - JP16H06421, JP17H03224.

[1] Y. Kumazaki *et al*., J. Electorochem. Soc., 164 (7) H477-483 (2017).

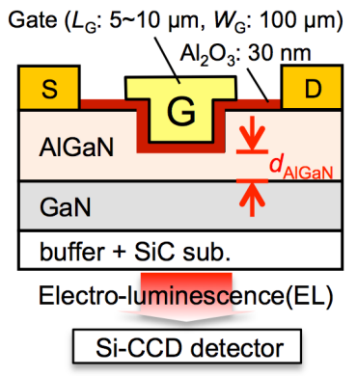

Fig. 1 Schematics of recessed-gate AlGaN/GaN HEMT and configuration for EL observation.

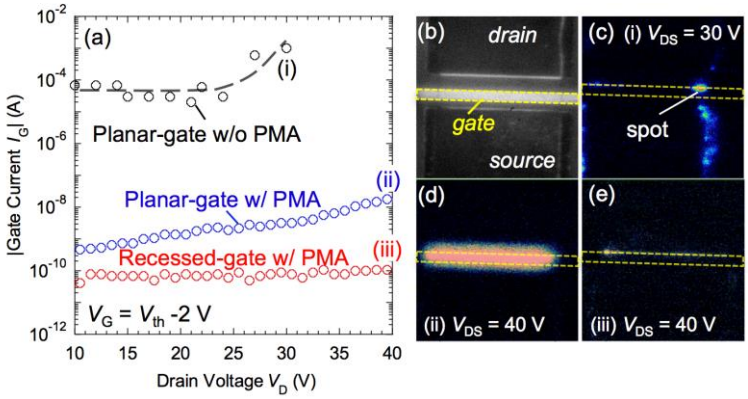

Fig. 2 (a) $|I_G|$-V_D characteristics. (b) Microscope image and EL emission images corresponding to (c) Planar-gate w/o PMA @ V_{DS} = 30 V, (d) Planar-gate w/ PMA @ V_{DS} = 40 V and (e) Recessed-gate w/ PMA @ V_{DS} = 40 V.