InAlGaN/GaN HEMTs with n-GaN Regrowth at Ohmic Contact Regions

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For high–voltage RF applications, Gallium Nitride (GaN) based High Electron Mobility Transistors (HEMTs) stand out for a high density of two-dimensional electron gas (2DEG) and a high saturation velocity of electrons. Improving the electrical performances of HEMTs, particularly in terms of Power Added Efficiency (PAE) and Power Output (P_{out}), requires a reduction in parasitic resistances [1]. The contact resistance (R_c) and access resistance constitute parasitic resistances. The GaN regrowth with a high level of n-doping is an approach which allows to obtain a lower contact resistance and decrease the distance between the source and drain contacts. This approach eliminates the need for high-temperature annealing of ohmic contacts, thus avoiding metal diffusion and providing better pattern definition.

In this work, we study the performances of silicon-doped gallium nitride ohmic contacts on InAlGaN/GaN HEMT structures. InAlGaN/GaN epitaxial layers were carried out in a close coupled showerhead Metal Organic Vapor Phase Epitaxy (MOVPE) on a 100 mm semi-insulating SiC substrate. After the growth of HEMT structure, the sample is processed in order to define regions where the n+-GaN regrowth will be located. Thus, a SiO_x dielectric mask is deposited by Plasma Enhanced Chemical Vapor Deposition (PECVD). Then the SiO_x mask was pattered by Reactive Ion Etching (RIE) to define selective epitaxial regions. The quaternary barrier and partial GaN channel were removed by Inductively Coupled Plasma (ICP). The sample is cleaned before being loaded into the MOVPE reactor. The n-GaN regrowth is realized at low temperature (850°C) in order to no damage the epitaxial HEMT structures and in particular to avoid desorption of the indium contained in the barrier. The regrowth conditions are optimized in order to obtain a high a doping level (1.10^{20} cm^{-3}) and present a selectivity [2].

With the n-GaN regrowth at ohmic contact regions, a lower resistance contact is obtained ($R_c < 0.1$ ohm.mm). This contact resistance achieved is five times lower than the standard annealed ohmic contact. A significant improvement in transistor performances was noted with this technique, combined with a reduction in the distance between metal contacts. Indeed, an improvement of PAE and Pout were measured. This approach is therefore promising for improving the electrical performance of HEMT devices

References

[1] Y. Zhou et al. , Appl. Phys. Lett. 120, 062104 (2022).
[2] C. Pitaval et al., Phys. Status Solidi A, 220: 2200476.