Electronic Devices Based on Two-Dimensional Electron Gas (2DEG) in Nitride Polar Structures

Pawel Prystawko

Institute of High Pressure Physics, PAS Sokolowska 29/37, 01-142 Warsaw, Poland
and
TopGaN Ltd, Sokolowska 29/37, 01-142 Warsaw, Poland

Wide bandgap semiconductor system of AlGaN/GaN has a number of features important in manufacturing of electronic devices: strong interatomic bonds, high electron mobility, high electron saturation drift velocity, high critical electric field, as well as thermal stability. Planar devices with 2DEG formed in polar nitride structures show excellent performance in high power, high frequency devices, as well as in power switching. However, these devices are still far from the GaN/AlGaN material system physical limits [1].

In my lecture, I will present an advantage of piezoelectric and spontaneous polarization fields in formation of 2DEG used in HEMT (High Electron Mobility Transistors) structures and also in current aperture vertical electron transistors (CAVET) which have been less investigated so far but they could get closer to material system limitations [2].

State-of-the-art devices demonstrated already have power density above 30W/mm and f_{MAX} above 300GHz for RF HEMTs and switching capability of 10kA/cm^2 in vertical devices.

I will show achievements of our Lab, including:

- growth of HEMTs on laterally patterned SiC substrates,
- growth of HEMTs on Ammono GaN [3] bulk semiinsulating substrates with the very low dislocation density,
- Schottky diodes with 700V breakdown voltage on Ammono GaN

Role of substrates and influence of dislocations will be addressed.

Electronic devices based on planar 2DEG structures in nitrides together with vertical current transport structures will continue gradually outperform and probably replace some of the silicon-based transistors and silicon carbide counterparts in near future.

[1] T. Palacios, Y. Dora, A. Chakraborty, C. Sanabria, S. Keller, S. P. DenBaars, and U. K. Mishra, “Optimization of AlGaN/GaN HEMTs for high frequency operation,” *Physica Status Solidi A*, vol. **203**, no. 7, pp. 1845 – 1850, May 2006.

[2] S. Chowdhury, B. L. Swenson, M. H. Wong, U. K. Mishra, Semicond. Sci. Technol. **28** (2013) 074014

[3] R. Dwilinski, R. Doradzinski, J. Garczynski, L.P. Sierzputowski, A. Puchalski, Y. Kanbara, K. Yagi, H.Minakuchi, H. Hayashi, *J. Crystal Growth* **310**, 3911 (2008).