



Technological Issues and Future Prospects of GaN and Related Semiconductor Devices (Vol.4): Manufacturing Cost of GaN Power Device

Gallium nitride (GaN) is expected to have significant energy-saving benefits in power devices due to its high electron mobility and wide bandgap. An evaluation of competitiveness of GaN device with other devices was performed through estimation of the manufacturing costs about vertical MOSFETs assuming the manufacturing process, the device structure and the substrate costs.

- Manufacturing costs of GaN MOSFETs (Figure 1) were estimated to be 20,000 JPY per chip for 10 mm planer-type chips with 4 inch GaN substrates (costing 400,000 JPY per piece). The cost for trench-type chips were estimated to be 16,000 JPY per chip due to the shorter manufacturing process.
- Reductions in substrate costs are the most important as they account for nearly 60% of total manufacturing costs. If problems relating to crystal growth are resolved, prices can be reduced to 10,000 JPY per substrate [1] and 5,000 JPY per chip will be possible.
- Epitaxial growth equipment accounts for 50% of total facility costs. It is expected to reduce the cost to 11,000 JPY per chip simply by using 6 inch substrates instead of 4 inch.
- To compete with Si or SiC devices, it is necessary to reduce the manufacturing cost by realizing large-diameter substrates, multiple wafer processing, reduced production time, and a high overall yield. Development of trench-structures and/or ion implantation technology for p-layer formation will improve the competitiveness of the GaN device.

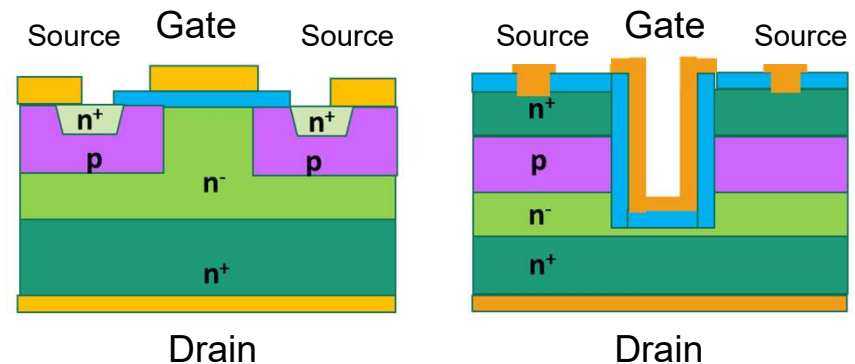


Figure 1: Vertical GaN MOSFETs (Left: Planar-type, Right: Trench-type)

Proposals for Policy Development

Supplying high quality and low-cost substrates and improving the efficiency of the manufacturing process are essential for reducing the production cost of GaN devices. Towards these ends, following researches are needed.

- 1) Research on both GaN single crystal growth and SiC substrate utilization to reduce substrate cost.
- 2) Research on using large diameter substrates and reducing process time for improving efficiency of epitaxial process and research on new device structure which leads to reduction steps of epitaxial growth process. Furthermore, future basic researches on new film forming process and new device structures.

[1] LCS Proposal Paper for Innovation Policy Development “Technological Issues and Future Prospects of GaN and Related Semiconductor Devices (vol. 2): Manufacturing Costs of GaN Crystals and Substrates” Feb. 2018.