Bulk GaN growth

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Application of gallium nitride (GaN) substrates in electronic and optoelectronic industries is constantly increasing. In order to fabricate wafers, GaN crystals of the highest structural quality and desired electrical (and sometimes optical) properties must be grown. Today, there are three main GaN crystallization methods: i/ halide vapor phase epitaxy (HVPE) with its derivatives: halide-free VPE and oxide VPE [1-3]; ii/ sodium-flux [4]; and iii/ ammonothermal. The last approach can be basic or acidic depending on what mineralizer is used to increase the solubility of GaN in the feedstock zone [5,6].

In this paper we will focus on HVPE and basic ammonothermal growth of GaN. Wherein, the HVPE as the best method for crystallization of drift layers necessary for construction of high-power vertical electronic devices (FET transistors, Schottky diodes) will also be discussed.

Recent results obtained in the basic ammonothermal growth will be shown. Structural, electrical, and optical properties of ammonothermal highly conductive (n-type) and semi-insulating (SI) GaN (Am-GaN) will be analyzed. Based on the presented results, main limiting factors of bulk Am-GaN crystallization and new ways for improving this process will be discussed. It will be shown: i/ how to eliminate lateral growth during crystallization in vertical directions; ii/ how to prepare the surface of a native seed in order to minimize residual stress in the growing crystal; iii/ how to obtain a uniform and constant supersaturation in the growth zone where more than fifty 2.2-inch crystals are placed; iv/ what kind of growth mode is required to obtain a uniform concentration of wanted and unwanted dopants in bulk Am-GaN.

In the case of HVPE-GaN growth, the advantages of using native seeds will be demonstrated. All barriers for growing truly bulk HVPE-GaN will be analyzed. They will be compared to the limiting factors existing in Am-GaN growth. Morphology and its influence on uniform doping of bulk HVPE-GaN crystals will be discussed in detail. The main dopants used for growing n-type and SI crystals will be shown.

In conclusion, it will be explained what else we need to know about the crystallization of truly bulk GaN by the two methods described above. Some aspects of wafering of GaN crystals into substrates as well as seeds will also be summarized.

References

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