A universal model of bulk GaN growth

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Gallium nitride (GaN) is an extremely important material from the point of view of optoelectronic and electronic devices. Currently, bulk GaN is crystallized by three methods: from the gas phase by Halide Vapor Phase Epitaxy (HVPE) and from the solution by ammonothermal as well sodium flux (Na-flux) method. These methods are still developed and improved to obtain crystals of the highest structural quality and with desirable homogeneous properties [1]. However, the preparation of such crystals and the development of the mentioned technologies require a basic analysis of growth and a deep understanding of its mechanisms. Therefore, an analysis of the growth morphology of the bulk crystal in the individual growth phases is crucial to achieve this goal.
Conducting the process (regardless of the method) in a stable manner is the basis for obtaining a homogeneous crystal in terms of composition and structural quality. The most stable mode of growth is the propagation of steps, the source of which may be misorientation or a hexagonal growth hillock. Disturbances at the crystallization front in the form of changes in the growth mode, from step propagation to step bunching growth have a significant impact on the quality of the grown crystal. The appearance of step-bunching may result in the formation of inclusions, point defects a change in the incorporation of impurities and the generation of dislocations [2]. An analysis of the factors that influence the changes in the growth mode also seems justified.

In this work, a universal model of GaN growth on a misoriented native seed will be presented. The successive stages of growth in terms of growth morphology will be discussed in the context of their influence on the properties and structural quality of the crystal. Data from a several-year GaN growth analysis using HVPE and ammonothermal methods will be shown. The evolution of the crystal growth from step propagation mode, through the reconstruction of the (0001)/(000-1) plane (depending on the growth method), to the hillock formation will be demonstrated. The influence of growth modes on the structural quality of the obtained layers will be discussed. Particular attention will be paid to an analysis of the interaction of hillocks. Variants of their mutual connection and interaction as well as their influence on the morphology of the growth will be presented. The perspectives of crystal growth with the participation of one hillock will be shown.

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