Low-Dislocation-Density Gan And Algan Using Epitaxial-Lateral-Overgrowth Method

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GaN, AlGaN and AlN are the most promising III-nitride semiconductors for ultraviolet LEDs and LDs, because they have direct wide bandgaps from 3.4 eV up to 6.2 eV. It has been a key issue to grow those semiconductors with low dislocation densities in order to realize ultraviolet LEDs and LDs with high-efficiency.

The epitaxial-lateral-overgrowth (ELO) is one of the most important techniques to obtain low-dislocation-density III-nitride epitaxial layers. We found that the threading dislocation density in GaN epilayers is dramatically reduced to the order of 10^5 -10^6 cm^{-2} with good reproducibility in particularly by using the facet-controlled-epitaxial -lateral-overgrowth (FACELO). The facet of an underlying layer should be controlled under appropriate growth conditions; growth temperature, growth time, growth pressure, ambient gas, doping gas etc., because existence of the inclined-facets on the grown surface is essential to bend threading dislocations and reduce their density.

Up to now, the FACELO technique has been developed further to reduce the low dislocation density in AlGaN epilayers grown by metal organic vapor phase epitaxy (MOVPE). We successfully obtained crack-free and also high-quality AlGaN with dislocation density of lower than 10^{10} cm^{-2} by using an epitaxial AlN film on sapphire (0001) as a substrate. Recently, we have proposed the new approach of growing low-dislocation-density $Al_xGa_{1-x}N$ (x=0.4-0.5) by using AlN epilayer with incline-facets. Dislocation density in the AlGaN was 10^7-10^8 cm^{-2}. Optical properties and dislocation distribution were examined by cathodoluminescence (CL) and TEM methods. We discussed enhancement of lateral growth rate of AlGaN on the AlN with inclined-facets.