

Conductive Al-rich AlGa_N Alloys for Deep UV Photonics

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This talk will provide a brief overview on the current status, future perspective, and technical challenges of highly conductive Al-rich AlGa_N alloys. Al-rich AlGa_N alloys are ideal materials for the development of chip-scale photonic devices such as deep ultraviolet (UV) emitters and detectors operating at wavelengths down to 200 nm. Highly conductive n- and p-type Al-rich Al_xGa_{1-x}N alloys with Al content (x) as high as 0.7 are required in deep UV emitters ($\lambda < 300$ nm). Currently, increased defect and dislocation densities and reduced conductivity and light extraction in AlGa_N alloys with increasing Al content are the main obstacles for achieving high performance deep UV light emitting diodes (LEDs). We employ deep UV photoluminescence (PL) along with Hall-effect measurements to monitor and hence to optimize the growth conditions of Al-rich AlGa_N epilayers. For Al_{0.7}Ga_{0.3}N, we have achieved a record low room temperature n-type resistivity of 0.007 Ωcm by Si doping and confirmed p-type conduction at high temperatures with a p-type resistivity of about 40 Ωcm at 800 K with Mg doping. By minimizing the PL emission intensity associated with cation vacancy (V_{Al}) related transitions by varying the growth parameters, we have also achieved the conductivity control in n-type AlN. The optimized growth conditions of Al-rich Al_xGa_{1-x}N were incorporated into 280 nm deep UV LED structures. High quality AlN epilayer was employed as a template to improve the overall material quality of the deep UV LED structure, while AlN/AlGa_N superlattice was used to release the strain prior to the growth of n-type Al-rich AlGa_N cladding layer. Additionally, Mg-doped Al_{0.7}Ga_{0.3}N was used as an electron blocking layer to enhance the radiative recombination in the active region. We have achieved high quality deep UV LEDs for wavelength down to 280nm.