Abstract

The aim of this work was the growth and the characterization of cubic GaN, cubic AlGaN/GaN heterostructures and cubic AlN/GaN superlattice structures. Reduction of the surface and interface roughness was the key issue to show the potential for the use of cubic nitrides in futur devices. All structures were grown by plasma assisted molecular beam epitaxy on free standing 3C-SiC (001) substrates.

In situ reflection high energy electron diffraction was first investigated to determine the Ga coverage of c-GaN during growth. Using the intensity of the electron beam as a probe, optimum growth conditions were found when a 1 monolayer coverage is formed at the surface. GaN samples grown under these conditions reveal excellent structural properties. On top of the c-GaN buffer c-AlGaN/GaN single and multiple quantum wells were deposited. The well widths ranged from 2.5 to 7.5 nm. During growth of $Al_{0.15}Ga_{0.85}N$/GaN quantum wells clear reflection high energy electron diffraction oscillations were observed indicating a two dimensional growth mode. We observed strong room-temperature, ultraviolet photoluminescence at about 3.3 eV with a minimum linewidth of 90 meV. The peak energy of the emission versus well width is reproduced by a square-well Poisson-Schrödinger model calculation. We found that piezoelectric effects are absent in c-III nitrides with a (001) growth direction. Intersubband transition in the wavelength range from 1.6 μm to 2.1 μm was systematically investigated in AlN/GaN superlattices (SL), grown on 100 nm thick c-GaN buffer layers. The SLs consisted of 20 periods of GaN wells with a thickness between 1.5 nm and 2.1 nm and AlN barriers with a thickness of 1.35 nm. The first intersubband transitions were observed in metastable cubic III nitride structures in the range between 1.6 μm and 2.1 μm.