TF-P015

Epitaxial growth of GaN thin films on atomically stepped lithium niobate ($LiNbO_3$) substrates

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This study presents the growth of epitaxial thin film of GaN on atomically flat lithium niobate ($LiNbO_3$)substrates by molecular beam epitaxy(MBE). High temperature treatment of as-received $LiNbO_3$ wafers has been carried out to obtain atomically flat surface and to remove the surface damage due to mechanical polishing. Annealing at 1000^oC for 2hrs. produces the optima lsurface smoothness. The microsteps are nearly parallel and periodical most all over the sample. AFM measurements displayed that the step height on Z-cut substrates was 0.27 nm, which was well accordance with the distance between oxygen layers along the c-axis of the hexagonal unit cell of $LiNbO_3$ crystals. Also, the step terrace width is about 200 nm and the surface roughness is 0.111 nm for a scan area of a 3μm x 3μm. We obtained GaN films with relatively high quality on the atomically-flat $LiNbO_3$ substrates with AlN buffer layers. The structural and optical properties were performed by XRD, PL, and AFM measurements. The full-width-at-half maximum (FWHM) values of the XRD (0002) GaN rocking curves were 122.14 arcsec and 168.80 arcsec for GaN film grown on the positive side (+z-$LiNbO_3$) and negative side (-z-$LiNbO_3$), respectively. AFM measurements showed that the RMS value of GaN films are 0.鷆 9 nm for the −z -$LiNbO_3$ substrate and 1.0玢甄 nm for the+z -$LiNbO_3$, respectively. The optical properties of these samples were characterized by photoluminescence (PL) measurement using a He-Cd laser (325nm) as the excitation source at room temperature. The typical PL spectrum of GaN film grown on the both side of $LiNbO_3$ substrate reveals a strong band-edge emission peak at 360nm(3.45eV). We will discuss that the effects of the polarity of the $LiNbO_3$ subtrates on the crysta lstructure and polarity of GaN films.