EMC 2015 Late News - Wide-Bandgap Materials - Abstract Extension

High quality wurtzite BAlN with high B content by metalorganic chemical vapor deposition

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BAlN films were grown by flow-rate modulation epitaxy on AlN. Figure 1 shows x-ray diffraction (XRD) peaks of 3-μm AlN/(0001) sapphire template layer and 45-nm BAlN layer at 2θ angles of 36.146° and 36.481°, corresponding to *c*-lattice constants of 4.966 and 4.922Å, respectively. The BAlN XRD peak is very clear and distinct given the small thickness, indicating good wurtzite crystallinity. It is not possible to directly calculate the B content from XRD alone because of uncertainty of the lattice parameters and strain. However, based on the angular separation of the XRD peaks and *c*-lattice constant difference, the B content is estimated to be ~7% [1], which is considerably higher than those of high-quality wurtzite BAlN layers reported before [2,3,4]. To obtain the accurate B content, Rutherford backscattering spectrometry (RBS) measurements are being made.

Figures 2(a)-(b) show a high-resolution cross-sectional transmission electron microscopy (TEM) image with a magnification of 150 kx taken at *a*-zone axis ([11-20] projection) and diffraction pattern after fast-Fourier transform (FFT). A sharp interface between the AlN and BAlN layers is observed. In addition, the BAlN film exhibits a highly ordered lattice throughout the entire 45nm thickness without the polycrystalline columnar structures found in previous reports [1,5]. The FFT image confirms a wurtzite structure oriented along *c*-axis.

Figure 3 shows a 5×5 μm^2 atomic force microscopy (AFM) image of BAlN layer surface. The root-mean-square (RMS) surface roughness is ~1.7nm. Surface macro-steps were found on the surface due to longer diffusion length of group-III atoms than the expected step terrace width. This indicates there is potential to lower the growth temperature to create smoother surfaces while maintaining crystallinity which has been observed for AlN [6].

In summary, a high-quality wurtzite BAlN layer with relatively high B content ~7% was demonstrated by MOCVD. Refractive index will be measured to facilitate design of distributed Bragg reflector (DBR) for deep UV vertical-cavity surface-emitting laser (VCSEL).

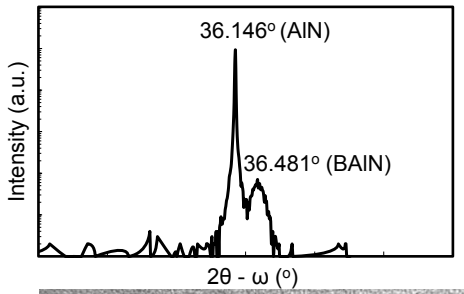

Figure 1.

XRD scan of 45-nm BAlN layer grown on AlN template layer on sapphire substrate.

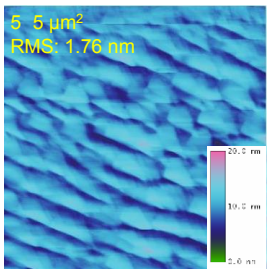

Figure 3.

A 5×5 μm^2 AFM image of BAlN layer surface. The height scale is 20 nm.

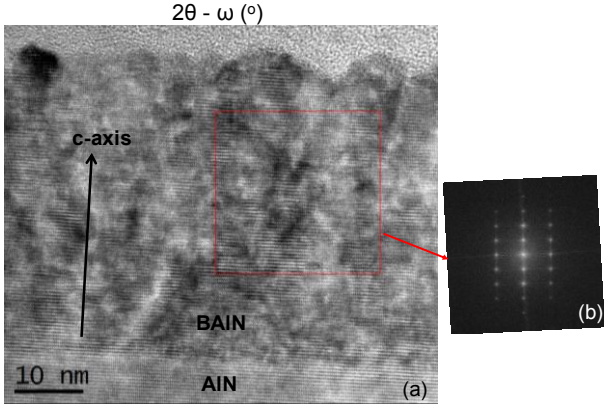

Figure 2.

(a) A high-resolution TEM with a magnification of 150 kx taken at *a*-zone axis ([11-20] projection).
(b) The diffraction pattern after FFT, indicating a wurtzite structure.

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