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Epitaxial Growth of Aluminum Nitride Thin Film on Sapphire Substrate by ECR Plasma Method

ECRプラズマ法によるサファイア基板上にエピタキシャル成長した窒化アルミニウム薄膜

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Introduction

Aluminum Nitride with hexagonal structure (hex-AlN) exhibits a large piezoelectric property, a high ultra-sonic velocity as well as a wide direct band gap up to 6.2 eV. The band gap of III-nitrides covers from 0.7 eV (InN) to 6.2 eV (AlN). The deep ultraviolet (UV) region provided by AlN is one of special attractions.

In this paper, electron cyclotron resonance plasma-enhanced sputtering deposition (ECR - sputtering) was employed to prepare epitaxial hex-AlN at relatively low substrate temperature.

Experimental

AlN thin films were prepared on *c*-plane sapphire substrates, Al_2O_3(0001), using a solid-source ECR plasma system (MES-AFTY Corp. AFTEX-6000). The Aluminum target was placed in argon plasma generated by the ECR plasma reactor. The substrate temperature was varied between room temperature and 500°C by using a lamp heater. The microwave (MW) power was varied between 300 and 800 W. The size of substrate holder was 4 inches in diameter. An X-ray diffraction (XRD) and atomic force microscopy were employed to evaluate crystallinity and surface morphology. The transparency was also measured by a spectrophotometer.

Results and Discussion

An ordinal θ-2θ and φ scan of AlN(113) verified the epitaxial growth of AlN(001) deposited at substrate temperature of 500°C with film thickness of even 20 nm. The surface roughness showed flatness of Ra ~ 0.2 nm and 0.4 nm with film thickness of 20 and 100 nm, respectively. The XRD rocking curve showed good quality with 0.06° and 0.045° of full width at half maximum (FWHM) on film thickness of 20 and 100 nm, respectively.

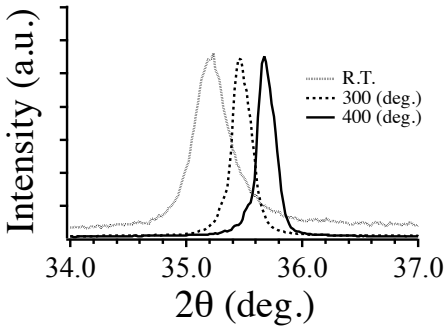

Fig.1 XRD θ-2θ scan of AlN(001) film deposited on sapphire substrate by ECR plasma method. The lattice constants were varied with the substrate temperature.

Interestingly, the lattice constants were varied with substrate temperature as shown in Fig. 1. For GaN, it is known that the band gap is varied with lattice constant, which controlled by lattice mismatch with buffer layer. In order to estimate the effect of band gap on variation of lattice constants, *ab init* [1,2] was employed using Local Density Approximation (LDA) and generalized gradient approximations (GGA) together with GW method. The evaluation of band gap in experimental is now in progress to be compared with the theoretical results obtained by the first principle method.

References

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