ラジカル励起MOCVD法によるSi(111)基板上のInN薄膜の低温成長

Low-Temperature Growth of InN Films on Si(111) Substrates by Radical-Enhanced Metal-Organic Chemical Vapor Deposition

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1. Introduction:

Among group-III nitride materials, InN is potentially important for electronic and photonic applications because of its high electron mobility, high electron saturation velocity and its narrow direct band gap around 0.7 eV. By the conventional MOCVD, the growth of InN is difficult because the growth temperature needed to be kept lower than 500°C to prevent the InN dissociation and the decomposition of NH_3 (ammonia) was poor at such a low temperature. Referring to our previous results [1, 2], our newly developed radical-enhanced metal-organic chemical vapor deposition (REMOCVD) technique is promising to realize ammonia-free and relatively low-temperature growth, by which group-III nitride material can be grown with low product cost and high crystal quality even at low temperatures. In this work, the first attempt of InN low-temperature growth on Si(111) substrates was performed by this new technique.

2. Experiment:

The REMOCVD system was described in detail elsewhere [1, 3]. A chemically cleaned Si(111) substrate was set on the sample holder and exposed to H- and N-radicals generated with N_2 and H_2 plasma for deoxidizing and nitriding the substrate surface. Then, TMI was introduced near the substrate region in the downflow of N_2 plasma to grow an InN nucleation layer at room temperature for 10 min. Subsequently, an InN upper layer was grown at 100°C for 5 hours.

3. Results and discussion:

Surface morphology of the grown InN films was observed by AFM (atomic force microscope) as shown in Fig.1. The RMS (root-mean-square) roughness is 1.87 nm. Figure 2 shows a synchrotron XRD (synchrotron X-ray diffraction) 2θ-θ scan spectrum which was measured with the BL8S1 Beamline in the Aichi Synchrotron Radiation Center, Japan. Besides of the peak at 24.8° attributed to the (111) plane of Si(111) substrate, a peak at 27.4° can be clearly observed, which is attributed to the (0002) plane of InN. It suggests that the InN single crystalline film can be grown along the (0001) orientation on Si(111) substrates even at such a low growth temperature of 100°C by the REMOCVD. These preliminary results indicate that our REMOCVD has a potential for InN epitaxial growth at low temperatures.

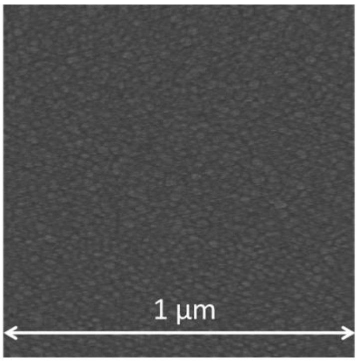

Fig.1 AFM top view of a InN/Si(111) sample.

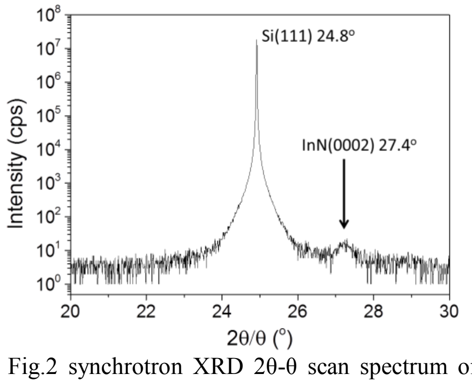

Fig.2 synchrotron XRD 2θ-θ scan spectrum of a InN/Si(111) sample.

[1] Y. Lu, et al., J. Crystal Growth **391**, 97 (2014).
[2] Y. Lu, et al., JSAP 60th Spring, 27p-A7-11 (Kanagawa Inst. Technol., Japan, Mar. 27-30, 2013).
[3] Y. Lu, et al., ISPlasma2014/ IC-PLANTS2014, 03pC12O (Meijo Univ., Japan, Mar. 2-6, 2014).