Gas source MBE growth of polycrystalline GaN on metal substrates and observation of strong photoluminescence emission

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GaN material system is gathering great interest from the viewpoints of their application to photonic and electronic devices. Recently, we have studied the growth of GaN layers on amorphous quartz glass substrates and observed the strong photoluminescence (PL) emission [1,2]. Furthermore, we have demonstrated both n-type and p-type dopings [3]. We pointed out the possibility of the fabrication of large area and low cost photonic devices [1]: the opening of the area of "Polycrystalline Semiconductor Photonics". We also suggested the possibility of the growth of polycrystalline GaN with strong PL emission on wide variety of substrates, such as metals, polycrystalline semiconductors, Si, and ferroelectric or magnetic oxides. Such various heterostructures will produce novel functions and devices. We have already succeeded the growth of strong PL emission polycrystalline GaN on SrTiO3 substrate [4]. In this paper we will report on the growth of GaN on various metal substrates and the observation of strong PL emission for the first time.

Polycrystalline GaN layers were grown on Mo, W, Ta and Nb metal substrates by gas source MBE using ion removal ECR radical cell. Sources used were elemental Ga and gaseous N2. Growth procedure and conditions were almost the same as those for the GaN on quartz substrates [1-3]. X-ray diffraction rocking curves (Fig.1) showed the preferential (0002) orientation indicating that the c-axis of GaN is mostly perpendicular to the substrate surface. The GaN surface was mirror-like for the naked eyes and the AFM observation showed a surface roughness of 20-30 nm. We have observed the strong PL emission with band-to-band transition from these polycrystalline GaN (Fig.2). The PL intensities were about 0.1-0.5 of that for the GaN on quartz substrate and that for the MOVPE-grown single crystalline GaN on sapphire substrate. Temperature variation of PL spectra showed the similar tendency to those for the single crystalline GaN (Fig.3). The details of the growth and characterization are presented in the conference.

Refereces

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[3] H. Asahi, K. Iwata, H. Tampo, R. Kuroiwa, M. Hiroki, K. Asami, S. Nakamura and S. Gonda, J. Cryst. Growth 201/202 (1999) 371.

[4] H. Tampo, H. Asahi, M. Hiroki, K. Asami and S. Gonda, Phys. Stat. Sol. (b) 216 (1999) 113.

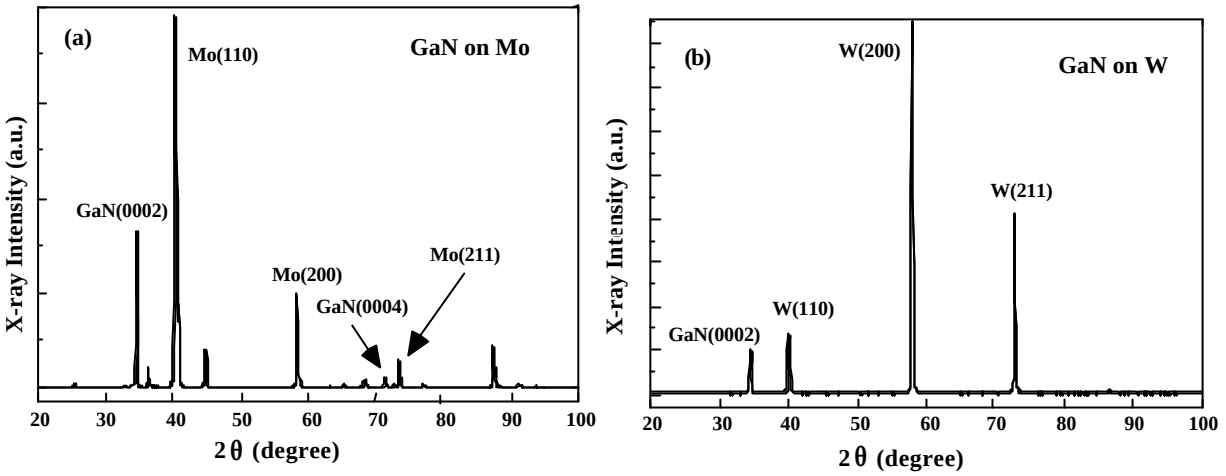

Fig.1 X-ray diffraction rocking curves for the GaN grown on Mo and W metal substrates.

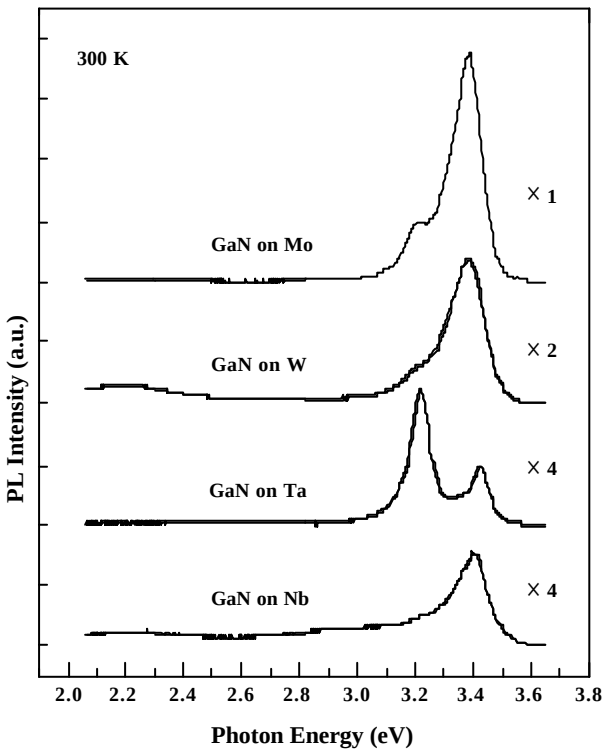

Fig.2 Room temperature PL spectra for the polycrystalline GaN grown on Mo, W, Ta and Nb metal substrates.

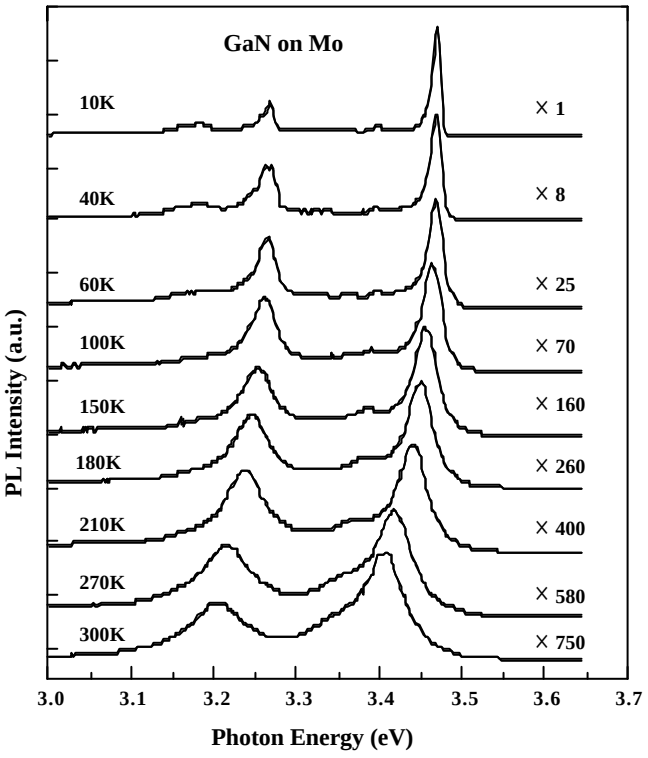

Fig.3 Temperature variation of PL spectra for the polycrystalline GaN grown on Mo substrate.