Materials Science

NW10A/2007G620

Polarized EXAFS study around In atom in m-$In_{0.06}Ga_{0.94}N$

Takafumi MIYANAGA[*1], Takashi AZUHATA[1], Shintaro MIKAMI[1], Takeyoshi ONUMA[2], Shigefusa F. CHICHIBU[2]
[1]Department of Advanced Physics, Hirosaki University, Hirosaki, Aomori 036-8561, Japan
[2]Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Aoba, Sendai 980-8577, Japan

Introduction

$In_xGa_{1-x}N$ is a key material in high-brightness blue and green light-emitting diodes (LEDs) and purplish-blue laser diodes. In order to make the emission mechanism clear in InGaN-based light-emitting devices, it is important to clarify the local structure around In atoms in active layers. Extended x-ray absorption fine structure (EXAFS) is a powerful tool in investigating local structures in thin layers composed of two or more elements.

For single quantum well (SQW) InGaN film, EXAFS study has been successfully performed and it was suggested that the aggregation of In atom along to c-axes is important for the high quantum efficiency of LED [1]. Recently, m- or a-plane (as non polarized plane) InGaN specimen has been developed in order to obtain the higher efficiency without the effect of the electromagnetic field. In this report we measured In K-edge EXAFS for m-InGaN film for three arrangements: the electric field of incident X-ray is parallel to c-axis, a_3-axis and vertical to m-plane (a-plane).

Experimental and Data analyses

300 nm $In_{0.06}Ga_{0.94}N$ film was deposited by MOVPE on GaN buffer layer/GaN substrate by HVPE method. The sample structure is shown in Fig.1.

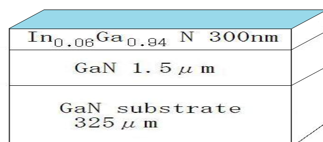

Fig. 1 Schematic structure of m-$In_{0.06}Ga_{0.94}N$ film

X-ray absorption measurements were made at beam line of NW10A at Photon Factory, KEK. Data were collected with a double-crystal monochromator using Si(311) crystals. Indium K-fluorescence emission was measured using a 19-element Ge solid-state detector. Data analyses was performed using XANADU code [2] and FEFF8.01 code [3].

Results and discussion

Figure 2 shows the $k\chi(k)$ spectra for m-$In_{0.06}Ga_{0.94}N$ film for three directions. The data quality is fairly good $k < 12A^{-1}$. Figure 3 shows the Fourier transforms of the EXAFS data shown in Fig. 2. We found the clear difference for the a_3-axis data. For the second peak detailed analyses performed by the curve-fitting analyses.The results are summarised in Tables 1-3. For the a_3-axis the In-In distance is longer than other directions.

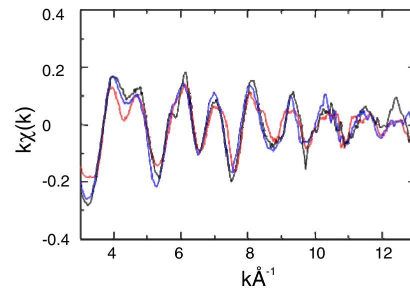

Fig. 2 $k\chi(k)$ spectra for $In_{0.06}Ga_{0.94}N$ film

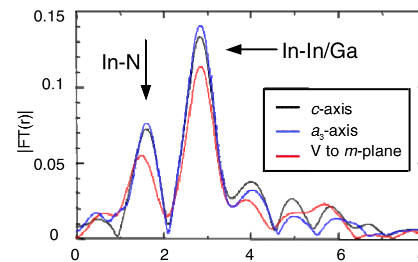

Fig. 3 Fourier transforms for $In_{0.06}Ga_{0.94}N$ film

Table 1: EXAFS parameters for parallel to c-axes

	r / A	N	σ / A
In-Ga	3.25	10.0	0.07
In-In	3.27	2.0	0.04

Table 2: EXAFS parameters for parallel to a_3-axes

	r / A	N	σ / A
In-Ga2	3.24	8.5	0.11
In-In2	3.35	0.5	0.03

Table3: EXAFS parameters for vertical to m-plane

	r / A	N	σ / A
In-Ga2	3.27	7.3	0.07
In-In2	3.28	1.7	0.04

*In-Ga2 and In-In2 indicates for in-plane atomic pairs.

References

[1] T. Miyanaga *et al*., Phys. Rev. B **76**, 035314 (2007).
[2] H. Sakane, *et al*, Jpn. J. Appl. Phys., **32**, 4641 (1993).
[3] S. I. Zabinsky, *et al*., Phys. Rev. B **52**, 2995 (1995).

* takaf@cc.hirosaki-u.ac.jp