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Local structure analysis around Al atoms in *m*-plane AlGaN films by polarized XAFS

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Introduction

The III-V nitrides have been interested as materials for blue and ultraviolet light emitters[1]. Wurtzite GaN, the most studied members of this group, has a direct band gap of 3.4eV, while the $Al_xGa_{1-x}N$, pseudo-binary alloys, provide direct gaps up to 6.01eV. It is attractive that they cover the area of ultraviolet rays. On the other hand, a lot of unclear problems still exist for the basic physical properties.

In the present report, the polarized XAFS studies have been carried out for the Al *K*-edge of *m*-plane $Al_xGa_{1-x}N$ thin films (x=0.58, 0.32).

Experimental

m-plane $Al_xGa_{1-x}N$ thin films (140nm thick, x=0.58, 0.32) have been grown up by using the NH_3 source molecular-beam epitaxy method on *m*-plane GaN substrate[2]. Al *K*-edge (1560eV) X-ray absorption spectra were measured on BL11A at Photon Factory, KEK, Tsukuba, using fluorescence mode with silicon drift detector (SDD).

To measure the polariztion dependency, we set the sample in three alignments: (1) the electric field vector of X ray is vertical to *a*- plane $(11\bar{2}0)$, (2) to *c*- plane (0001), and (3) to *m*- plane $(1\bar{1}00)$, respectively.

The EXAFS analyses were performed by XANADU code [3] and FEFF 8.10 code [4].

Results and discussion

Figure 1 shows XANES for *a*-, *c*-, *m*-directions of *m*-plane AlN and $Al_xGa_{1-x}N$ (x=0.58, 0.32). Peak intensities are different each other but the peak energies are the same in *a*- and *m*–direction $Al_xGa_{1-x}N$. On the other hand, the spectrum for *c*-direction is different from those for *a*- and *m*- direction.

Figure 2 shows the Fourier transforms of EXAFS for *a*-, *c*-, *m*-directions of *m*-plane AlN and $Al_xGa_{1-x}N$ (x=0.58, 0.32). The first peak around 1.8 Å is contribution from Al-N, and the second peak around 2.4 Å is from Al-Al/Ga atomic pairs. Three kinds of orientational dependences in EXAFS can be seen. The substantial change was not seen in the Fourier transform. The ratio of peak intensity between first and second peaks for $Al_xGa_{1-x}N$ is different from that for AlN. More quantitative analysis is in progress for XANES and EXAFS now.

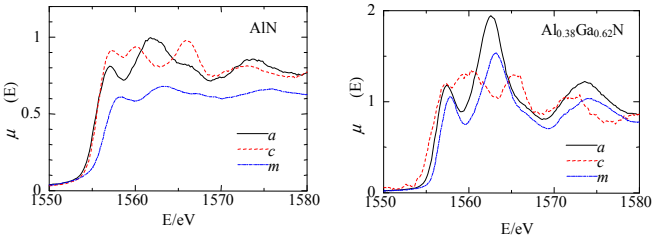

Fig. 1 Al *K*-edge XANES of *a*-, *c*-, *m*-directions of *m*-plane AlN (2.1μm thick) and $Al_xGa_{1-x}N$ (140 nm thick, x = 0.38, 0.58).

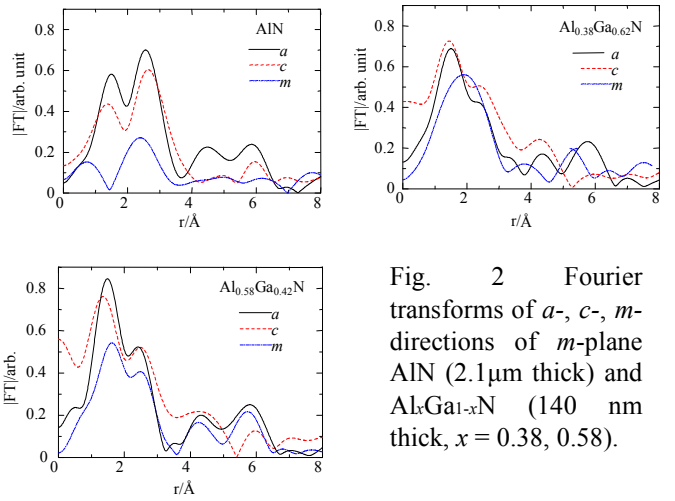

Fig. 2 Fourier transforms of *a*-, *c*-, *m*-directions of *m*-plane AlN (2.1μm thick) and $Al_xGa_{1-x}N$ (140 nm thick, x = 0.38, 0.58).

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