Study of GaInNAs local structure and nitrogen induced defects formation mechanism by XAFS observation

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The dilute nitrides such as GaInNAs is promising candidates for active layer material for next-generation infrared emitting laser diodes. However, their optical properties are not still well-known. One notable thing is uniform optical emission from GaInNAs/GaAs quantum well, which suggests that there is local inhomogeneous distribution of In content in the wells. In this experiment we performed x-ray absorption fine structure (XAFS) measurements of GaInNAs films to study their local structure.

GaInNAs films were grown on GaAs(001) substrate by plasma-assisted molecular beam epitaxy (p-MBE). There were four samples which with different In content. The XAFS measurements were performed at BL01B1 of Spring-8. The target absorption edge was In K at 27.9keV. Fluorescent x-ray was detected by solid state detector. A Si(111) double crystal monochromator was used.

In the fourier-transformed radial distribution function (RDF), we can see two main peaks coming from first nearest atoms (In-V) and second nearest atoms (In-III). The obtained first nearest and second nearest atomic distance depended on In content was shown in Figure 1. Indium concentration dependence of the first atomic distance looks same as that of InGaAs, which is linear function of indium content and is longer than virtual crystal atomic distance calculated from Vegard's law. On the other hand the dependence of the second atomic distance is far from that of InGaAs. The second atomic distances are about 4.20Å in the whole In content regime which is close to second nearest In-In interatomic distance in InAs and longer than InGaAs second nearest distance. This result suggests that incorporated nitrogen GaInNAs films enhances local InNAs segregation which can induce spatial modulation of the optical properties.

In-Situ Structural Analysis of Noble Metal Catalyst in Solvent under Reduction-Oxidation Conditions by Means of Quick XAFS

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Reduction-Oxidation on noble metal catalysts is practically important and environmentally friendly process. Palladium among the metals, has been widely and intensively studied and there were various applications in many fields of industry.

We have studied the oxidation-reduction reactions catalyzed by palladium catalyst in liquid phase. For this purpose, the in situ XAFS method was applied to investigate the time-course change in the oxidation-reduction state of palladium catalyst during reaction in the liquid phase.

Schematic illustration of a reactor cell was given in Figure 1. The reactor could be operated under the inner pressure of 1MPa and the temperature of 100°C.

Figure 1 Schematic view of solid-liquid phase in a reactor cell.

The experiment was conducted with the expectation that crystal structure of palladium changed in terms of the chemical interaction between catalyst and solvent. Although the structural change was expected to be small, it would be detected by using brillant X-ray source of Spring-8.

Figure 2 shows the Pd K-edge XAFS Fourier transforms of Pd catalyst reacted with various solvents. It could be seen that the particle size of Pd was smaller in water, compared with those measured under methanol or acetic acid.

Figure 3 shows Pd K-edge Fourier transforms of Pd catalyst measured at room temperature and 60°C in water. Small difference was found between the spectrum measured at room temperature and that measured at 60°C. There is little difference of spectra, so influence of temperature would be small.

In this study, we could obtain an important conclusion in that crystallographic structure of palladium changed through the interaction between catalysts and solvent. Further analysis is under progress.

Figure 2. Pd K-edge Fourier transforms of Pd catalyst reacted in various solvents.

Figure 3. Pd K-edge Fourier transforms of Pd catalyst reacted at rt. and 60°C in water.