Optical transitions in new semiconductor alloy $GaAs_{1-x}Bi_x$ with temperature-insensitive band gap

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The band-gap energies of $GaAs_{1-x}Bi_x$ were investigated by photoreflectance (PR) spectroscopy. We found that temperature coefficient of direct band-gap for $GaAs_{1-x}Bi_x$ becomes much smaller with increasing Bi-mole fraction.

Bi-containing III-V semiconductor alloys are hopeful for new semiconductor materials, because they are expected to have temperature-insensitive band-gaps, which are very important for semiconductor lasers operating in the 1.3-1.6 μm range. For this purpose we focus our attention on new GaInAsBi alloys. One of the Bi-containing alloys, $GaAs_{1-x}Bi_x$, has been grown on a GaAs(100) substrate by a horizontal low pressure MOVPE at substrate temperature below 365℃. It has been already reported that the temperature dependence of the PL-peak energy of $GaAs_{1-x}Bi_x$ is much weaker than that of GaAs.[1] In this study, we performed PR spectroscopy in order to investigate band-edge optical transitions of the $GaAs_{1-x}Bi_x$ alloys.

Bi-mole fractions of $GaAs_{1-x}Bi_x$ investigated in this study are 0, 0.005, 0.012, and 0.024. Figure 1 shows typical PR spectra obtained for the $GaAs_{1-x}Bi_x$ samples. The PR spectra for the three samples exhibit Franz-Keldysh oscillations (FKOs) above the band-gap energies due to built-in electric field at the surface. The FKO signal enables us to evaluate the band-gap energy. Figure 2 plots temperature dependence of the evaluated band-gap energies for the three samples together with that of GaAs. Temperature coefficients for these samples are 0.39, 0.18, 0.18, and 0.15 meV/K for x=0, 0.005, 0.012, and 0.024, respectively. These results show that a small amount of Bi-mole fraction causes the temperature-insensitive band gap. Furthermore, effective mass depending on Bi-mole fraction will be discussed.

[1] K.Oe and H.Okamoto, Jpn. J. Appl. Phys. **37**, 1283 (1998)

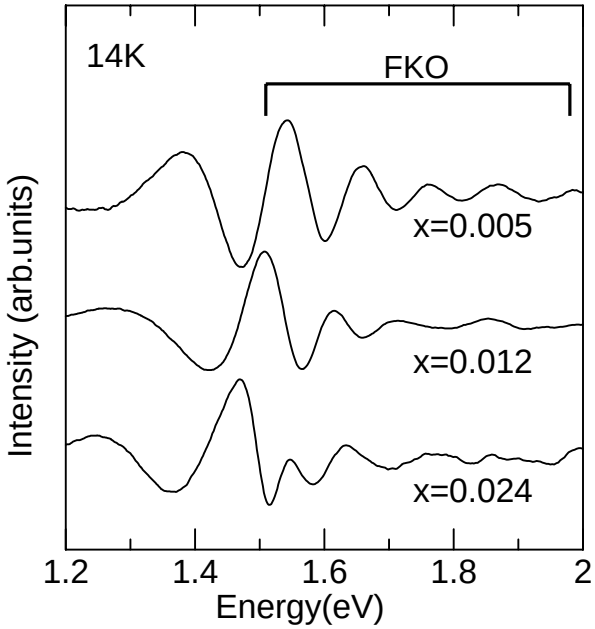

Figure 1 ：PR spectra of three $GaAs_{1-x}Bi_x$ at 14K.

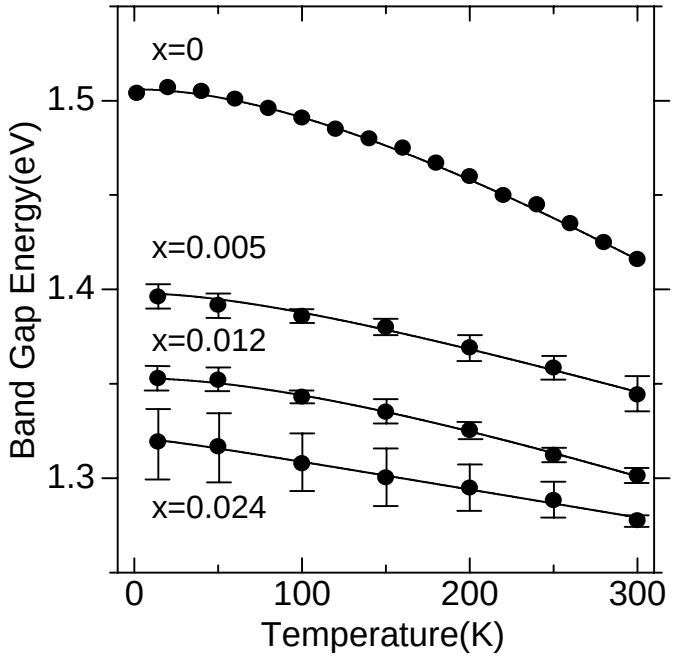

Figure 2：Temperature dependence of the band-gap energy of $GaAs_{1-x}Bi_x$ (x=0, 0.005, 0.012, and 0.024).