論文内容の要旨

論文題目　Development of n-GaAs based far-infrared photoconductors
(n 型ヒ素化ガリウムを用いた遠赤外線光電導素子の開発)

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The wavelength region $\lambda = 100\text{-}300\,\mu m$ is still less revealed spectral window for astronomical research. Recently, the space-born observatories, which can escape from the atmospheric absorption and emission, have become available for astronomical purpose, but the detector technology for this wavelength region is still undeveloped. The n-type gallium arsenide is a good candidate of material for high-sensitive extrinsic photoconductor in this wavelength region. However, the extrinsic photoconductor requires highly pure GaAs single crystal to achieve the high-performance. The Liquid Phase Epitaxy is a suitable crystal growth method to realize such a material for the photoconductor, because of sufficient purity of grown GaAs crystal and a large thickness available with this method. Our best sample of the GaAs crystal grown by the LPE actually showed a very high purity such as $n_{77K} = 2.5\times10^{13}$ cm^{-3} and $\mu_{77K} = 1.4\times10^{5}$cm^{2}V^{-1}s^{-1} that corresponds to the net impurity concentrations of $N_D = 6.3\times10^{13}$ cm^{-3} and $N_A = 3.8\times10^{13}$ cm^{-3}. We have also grown the doped GaAs by doping the selenium and tellurium element for the extrinsic photoconductors. By controlling doping quantity, the lightly doped GaAs:Te and GaAs:Se was successfully obtained (net donor

concentrations of $N_D \sim 10^{14}$ cm^{-3}).

The detector fabrication was tried using the LPE grown GaAs crystal. The fabricated GaAs extrinsic photoconductors showed the relatively high performance at T = 1.5 K. The spectral measurement of the GaAs photoconductors showed that they have sensitivities over wide wavelength range 150 - 320 μm. The highest performance detectors have achieved the $NEP \sim 3\times10^{-16}$ WHz$^{-0.5}$ at the wavelength of 285 μm, the sensitivity peak which corresponds to the electron excitation from the ground to second energy level in a hydrogen approximation for the donor.

Aiming to fabricate a multi-band photometer system for balloon-born telescope using 1 × 8 arrayed Winston cone and cavity optics, the performance of a prototype array optics was evaluated. Evaluation fo the system with the Winston cone, cavity and the GaAs photoconductor showed that the noise equivalent flux of ~1.9 Jy will be achieved in the balloon observations for the wide-band photometry with 1-seccond integration time and 160-320 μm wavelength band. For the spectro-photometry using the dispersion grating and the 1×8 array, a noise-equivalent flux of ~31Jy is expected assuming a 20 μm bandwidth and 1-second integration.