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นายภควัฒน์ วิเศษละคร

ศูนย์วิทยทรัพยากร
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FABRICATION AND STUDY ON SPECTRAL RESPONSE OF GaAs/GaAlAs
STAIRCASE BAND GAP PHOTODIODES

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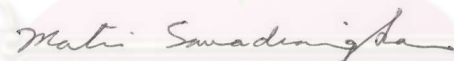
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This thesis is a study of the role of staircase bandgap structure on the spectral response of GaAs/GaAlAs photodiodes. Two structures have been designed: type A staircase bandgap structure which converges the bandgap energy of active layer from that of Ga_{0.6}Al_{0.4}As (P⁺) window layer to that of GaAs (n⁺) substrate and type B staircase bandgap structure which diverges the bandgap energy of active layer from that of GaAs (n⁻) underneath Ga_{0.6}Al_{0.4}As (P⁺) window layer to that of Ga_{0.6}Al_{0.4}As (N⁻) near to GaAs (n⁺) substrate. These two structures were compared with the structure of GaAs (n⁻) constant bandgap active layer. From the calculation point of view, the constant bandgap structure has the carrier generation occurs very close to the p-n junction where the high recombination rate exists. Moreover, there is no quasi electric field produced within active region, therefore, the quantum efficiency is not high. While type A staircase bandgap structure generates the carriers far distance from the junction, thus the recombination would not much effect as well as the electrons would drift very nearly toward the n-side. In addition, the quasi electric fields were produced within the active region due to the band edge gradients especially for conduction band. As a result, electron multiplication can be gained. In case of type B staircase bandgap structure, the carrier generation happens near the junction as the one of constant bandgap. Anyway, this structure is over than the constant bandgap structure that the quasi electric field can be produced in active region and especially for hole, consequently, hole multiplication can be gained. The quasi electric field of conduction band and valence band can be separately adjusted by either the thickness of Ga_{1-x}Al_xAs (N⁻) active layer or doping aspect. For the sake of this, the staircase bandgap structure can be applied to the Separate Absorption and Multiplication Avalanche Photodiode (SAM APD) to minimize the excess avalanche noise.

As for the experiment, we have fabricated 3 structures namely structure I, structure II and structure III. Structure I and II were grown by Liquid Phase Epitaxy (LPE) while the structure III which its pn junction was formed by Zn diffusion was grown by Molecular Beam Epitaxy (MBE). However, all experimental structures are the type A staircase bandgap. From the experimental point of view, all structures have the short wavelength spectral responses expand more broader than those of theoretical calculation because of the diffusion current. In addition, their spectral responses of active region were fluctuated due to the recombinations around each interface of active layer. As for the case of structure III, the spectral response between 400 and 750 nm depended upon the junction depth. The deeper the junction is, the lower the spectral response at short wavelengths exhibits.

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