Studies on Liquid Phase Epitaxial Growth of GaAs and Application to Static Induction Devices

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GaAs is a suitable material for power devices because of its inherent material advantages such as high electron mobility, direct bandgap, high avalanche breakdown voltage and short minority carrier lifetime. Therefore GaAs static induction (SI) devices are promising for high-speed, low-loss power switching devices. However their best design and fabrication process are not established. This thesis presents new fabrication techniques of GaAs SI devices by liquid phase epitaxy (LPE).

First, the most suitable design of GaAs power SI devices was obtained by numerical simulation for the guideline of development of their fabrication process. It proved that the GaAs SI devices require the active layer which has 20-30μm thick, impurity concentration of under $10^{13}cm^{-3}$ and carrier lifetime of over 10^{-8} sec. Therefore, new device process technologies such as the high purity GaAs growth, the lattice compensation technique and the inverse epitaxy are necessary for realization of GaAs SI devices.

Secondly, the dependence of the lattice constant of GaAs on impurity doping was estimated from X-ray rocking curves. The compensation effect of lattice constant on LPE grown GaAs has been confirmed by simultaneous doping of Te and Si.

Thirdly, the p^{+}-i junction which have a quite abrupt transition region and is good lattice match is formed by the LPE growth of a Ge-doped GaAs thick layer on an undoped GaAs substrate based on the concept of inverse epitaxy. However the semi-insulating substrate was converted to p-type conduction due to the loss of As because of the high temperature and long growth period.

Accordingly introduction of Ge/GaAs structure and consecutive LPE growth of Ge/GaAs was proposed for formation of the p^{+}-i junction at lower temperature in shorter time. The thick p^{+} Ge/p^{+} GaAs epitaxial layers were grown consecutively from Ga-As-Ge solution. Curvature of the specimen which depend on GaAs thickness amounted to zero at about 15μm GaAs thickness, hence the growth method can be utilized for GaAs SI devices.

Finally, the new growth method termed '*in-situ* solute synthesizing LPE' was proposed and was performed in order to realize high purity and high quality GaAs. In the future, if high purity materials and apparatus are used, the purity of the grown layer can be much impuroved.