§ 26. R&D of High Sensitive Radiation Detector

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The purpose of this study is to develope a radiation detector of high sensitivity, and to apply that detector to the LHD experiment. In addition, generally used possibility is pursued. In conventionally, radiation detectors in which reverse bias is applied to a diode comprising of semiconductors such as silicon or germanium are used for detecting ionizing radiation. Since the energy of radiation is absorbed in a solid part whose density is high, it ·is expected that the sensitivity is essentially high. However, there is not amplification in itself, and leak current is large. There are some limitations of use, such as cooling it in liquid nitrogen temperature.

For the above-mentioned situation, the element of semiconductor for light detection apparatus has been developed recently, which has function of amplitude own signal. An example is raised in the following. That is an element of a type called avalanche photo diode (APD). In the element, photoelectric effect is occurred as light absorption. This principle is the same as a normal semiconductor detector for radiation. Therefore, it is suggested that APDs has sensitivity for ionizing radiation theoretically. However, there have been few studies for this application. In this study, gallium/arsenic or indium/phosphorus are also assumed as element material. Because of high atomic number, absorption by photoelectric effect becomes large in different order of magnitude comparing with silicon. Sensitivity of low energy X-ray will be improved as a result. In addition, sensitivity of high-energy gamma ray may become high. We have a plan of theoretical examination in these elements.

In the last year, it had been cleared up that APD has a performance of radiation detection in high sensitivity.

In this year, a fabrication of Si-alternative semiconductor was progressed.

(1) Fabrication of a GaAs element

GaAs is suitable material in the gamma-ray spectroscopy which the band gap energy is wider in comparison with Si and Ge, and it works in room temperature. However, the non-dope layer of thickness more than 0.080 mm is necessary for gamma-ray detector, and super high purity is demanded. Super high purity GaAs liquid phase epitaxial growth (LPE) by a slide boat method was tried in an institution of Chubu University. The growth of crystal was conducted after heating a source plate in the circumstance of high purity hydrogen gas flow. The source plate was set at 800 degrees Celsius in 18 hours for purification. After that, a basal plate was charged in this circumstance for 90 min. The temperature was reduced in a ratio of 1.0 degrees Celsius /min.. Therefore, the growth of crystal was started at 798 degrees Celsius. As a result, about 30mm growth layer was obtained. Carrier density $2*10^{14}cm^{-3}$, mobility $50,000cm^2/Vs$ was got by electric evaluation with a Hall effect. It was not remarkable high purity because of lack number of growth. We need to reach the performance, the carrier density less than $10^{13}cm^{-3}$, and the mobility more than $100,000cm^2/Vs$, for making a radiation detector.

(2) Single crystal of GeSi

A single crystal of GeSi (Ge 5%, Si 95%) was made in Tohoku University. It was processed into surface barrier type to be able to examine this as a radiation detector. This detection element is effective about 20mm inside diameter, thickness 7mm. The sensitivity characteristic for gamma rays will be examined under controled temperature in order to reduce thermal noises.