§41. Development of Diamond Radiation Detectors for Charged/neutral Particles

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1. Introduction

Study on characteristics of confinement of high energy particles in deuteron-deuteron (DD) experiments in LHD is expected to lead design and performance expectation with high-accuracy of steady prototype fusion reactor based on academic and systematic understanding of plasma physics in high-temperature and high-density helical plasma.

It is possible to evaluated confinement performance of high-energy plasma from leaked charged or neutral particles from the plasma, thus such measurement is carried out using silicon semiconductor detectors in LHD. However, these detectors have lack of radiation hardness; replacement is required for DD experiment. In this study, diamond radiation detectors were developed to achieve high radiation hardness.

2.Experimantal

Single diamond crystal was homoepitaxially grown on a (100) surface of a HP/HT type IIa single diamond substrate by CVD method in Hokkaido Univ. Self-standing diamond was obtained by use of a lift-off method by AIST. After this process, electrodes were evaporated on both side of the self-standing diamond, and it was fabricated into a detector. Charge collection efficiency of the detector for holes and electrons were approximately 100% and 98.5%, respectively. In this study, response function measurement for protons with energy from 200 to 400 keV assuming ICF heating in LHD was carried out.

3.Experimental results

Figure 1 shows examples of response functions of the developed diamond radiation detector for protons with energy of 400, 300, 250 and 200keV. Although obvious peaks were observed until 250 keV, a peak was collapsed at 200 keV. From an extrapolating between proton energy and peak channels, it was revealed that the detector is blind to protons with lower energy than 100 keV. This result indicates existence of dead layer near entrance electrode. There is a possibility of influence of oxygen termination to obtain surface insulation properties. In the next year, research in surface treatment will be done to remove this dead layer.

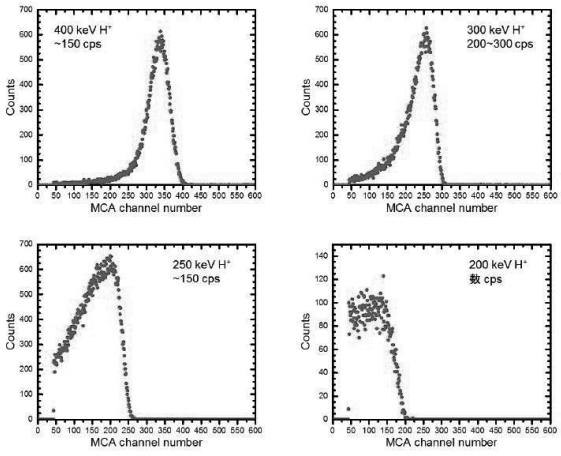

Fig. 1 Examples of response function of the diamond radiation detector for protons with energy from 200 to 400 keV.