§23. Development of Synthetic Diamond Radiation Detectors for DD Plasma Experiment in LHD

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1. Introduction

Synthetic diamond radiation detectors aiming at fast neutral particles and neutron measurement in the LHD has been developed in this study. Energy distribution of high-energy ions in plasma is able to decide by energy spectroscopy of fast neutral particles after charge exchange. In addition, energy spectroscopy for 14 MeV neutrons caused by DT burning is considered in time to come.

This year, CVD diamond single crystals were grown on HP/HT type IIa single diamond crystals with off-axis (001) surface. These crystals were removed from the substrate by use of a lift-off method. Charge carriers' transport characteristics were evaluated.

2. Growth of CVD diamond single crystals and fabrication of detectors

Off-angle measurement and the lift-off process were carried out in AIST. Off-angle treatment is typical method to suppress abnormal growth on homoepitaxial technique for diamond. The lift-off method made it possible to reuse of the substrate.

Typical growth condition was as follows, substrate temperature: 850°C, Gas pressure: 110 Torr, Methane concentration: 1 to 4%. Strong free excition recombination luminescence, evidence for high-quality diamond, were observed in cathode luminescence spectra. An aluminum and Ti/Au ohmic contacts were fabricated by evaporation.

3. Experimental results and discussions

Figure 1 shows an example of response for alpha particles from a ^{241}Am source. In this case charge collection efficiency of 100 % for holes and 97 % for electrons were achieved. Energy resolutions were 0.7 and 1.1 % for holes and electrons, respectively.

Figure 2 shows dependence of μτ value on methane concentration of growth condition. These values were conducted by dependence of charge collection efficiency on electric field obtained by the same measurement as show in Figure 1. With decrease of methane concentration, μτ values improved gradually. The μτ value obtained with methane concentration of 1 % was the same order of the best value reported in elsewhere. Reduction of residual gas in growth chamber and optimization of growth condition will be carried out in the next year.

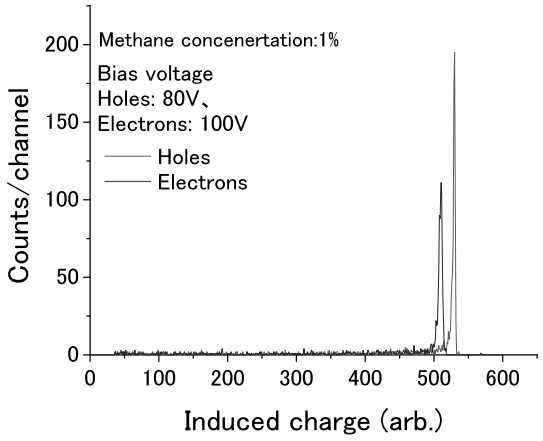

Fig. 1. An example of response for alpha particles from ^{241}Am.

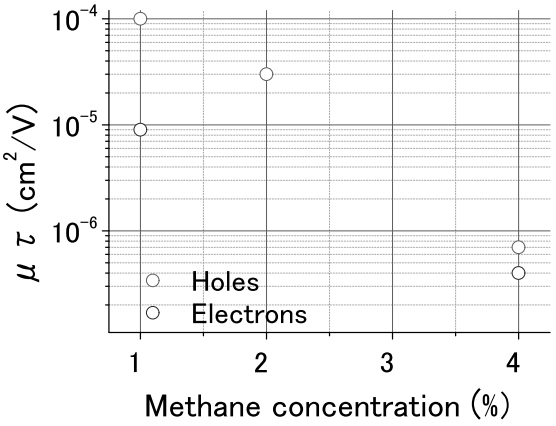

Fig. 2. Dependence of μτ value on methane concentration of CVD diamonds.