§30. Trial of Fast Neutral Particles and Neutron Measurement by a Synthetic Diamond Radiation Detector

Kaneko, J.H., Fujita, F., Konno, Y. (Hokkaido Univ.),
Watanabe, H., Chayahara, A., Umezawa, H.,
Tsubouchi, N., Shikata, S. (AIST),
Isobe, M.

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, HP/HT type IIa single diamond crystals with off-axis (001) surface were used as substrate in CVD homoepitaxial growth. By use of a lift-off method, self-standing CVD diamond single crystals were obtained, and then evaluations were carried out.

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. In addition, to suppress breakage of grown layer by residual stress caused by unconformity of lattice spacing between the substrate and a grown layer HP/HT type IIa diamond substrate were adopted. The lift-off method made it possible to reuse of the substrate.

Typical growth condition was as follows, substrate tempergure: 850°C, Gas pressure: 110 Torr, Methane concentration: 4%. Strong free excition recombination luminescence, evidence for high-quality diamond, was observed in cathode luminescence spectrum. An aluminum and Ti/Au ohmic contacts were fabricated by evaporation. The aluminum contact was combined with outer RF shield for experiment in the LHD.

3. Experimental results and discussions

Figure 1 shows an example of response for alpha particles from a 241Am source. Although growth condition has not been optimized, energy resolution of 0.7 to 1.0 % was achieved by use of long drift of holes. On the other hand, charge collection efficiency was 83% and 74.2% at bias voltage of 80 V for electrons and holes, respectively. These values were improved up to 100% and 95% with increasing of bias voltage to 120 V. Charge loss probably caused by nitrogen remained. In the next year, improvement of charge collection efficiency mainly by effort on reduction of residual gas in the growth camber.

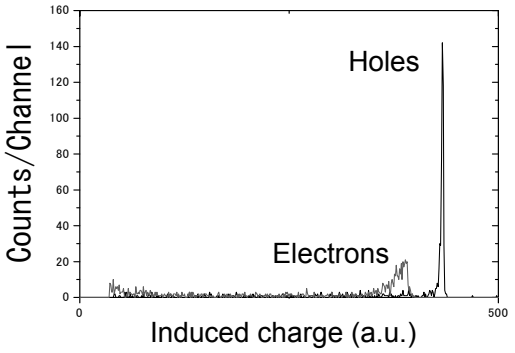

Fig.1 An example of response for alpha particles from ^{241}Am obtained by the CVD diamond single crystal grown by Hokkaido University (Thickness: 40 μm, Bias:+80 V)