§36. Traial on a ToF Measurement of Gamma-rays and Neutrons by a Diamond Radiation Detector with Fast Time Responce

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1. Introduction Ion temperature measurement has been carried out by a ToF measurement of neutrons using multi channel fast plastic scintillator system, i.e., MANDALA, at ILL of Osaka University. In a fast ignition ICF experiment, a ToF measurement for neutrons was sometimes disturbed by intense gamma-rays because scintillator had residual luminescence caused by the gamma-rays. By use of a diamond radiation detector with a fast time response, there is a possibility to measure accurate ToF spectrum of neutrons. In this development, diamond single crystals for radiation detectors were synthesized, then diamond radiation detectors were adapted in ICF experiments at ILL. In this stage, obtaining of basic data required for developing real diamond ToF spectrometer for gamma-rays and neutrons was main objective.

2. Fabrication of diamond radiation detectors and response measurement using UV pulsed laser In this year, CVD diamond single crystals were grown in Hokkaido University by a micro-wave assisted plasma CVD device. A HP/HT type IIa diamond single crystal, 5×5 mm, was used as a substrate in this crystal growth. The lift-off method was adopted for reuse of the substrate.

One of CVD diamond single crystals whose thickness was 40 μm was grown with substrate temperature: 800 ℃, Gas pressure: 110 Torr, methane concentration: 4%, growth time: 24 hours. Strong free exciton recombination luminescence was observed in a cathode luminescence spectrum. An aluminum Schtokky contact and a Ti/Au ohmic contact were fabricated on the crystal by evaporation technique. In addition, to protect from strong RF noise at the FIREX, the diamond detector was shielded by aluminum housing.

An example of response function for 213 nm UV pulsed laser is shown in figure 1. Time width of the pulsed laser was approximately 100 ps, and for motion of holes, output pulse was arrived at upper limit of time response of the measurement system. For motion of electrons, scattering probably caused by impurities of defects was observed.

3. Measurement on FIREX Judging from detection efficiency of the prototype diamond radiation detector and neutron yield of FIREX, direct measurement of 2.4 MeV neutrons caused by DD fusion was impossible. In addition, it was the first trial for our group, thus we focused on 1: quantitative evaluation of RF noise, 2: trial for gamma-ray detection caused by fusion.

The detector was settled at 10.2 cm from the target. The detector was connected with a digital oscilloscope, analog bandwidth: 600 MHz, with double shielded SMA cable. The detector and cable was covered by aluminum foil. The neutron yield was approximately 1×10^7 n/shot. Gamma burst was estimated arrived at 137 ns from the trigger signal, however no obvious change was observed in the output shignal. Noise level was suppressed by surrounding Pb of 20 mm in thickness. Further measures for RF noise is requiered in the next step.

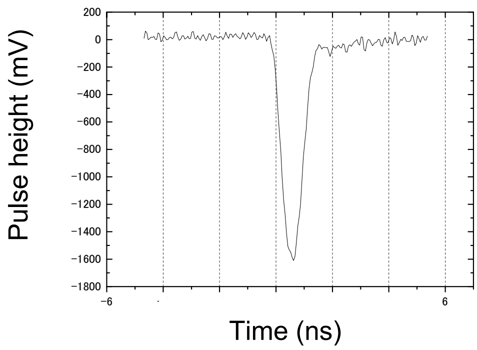

Fig 1. Examples of time response for 213 nm pulsed laser obtained by CVD diamond single crystal grown in Hokkaido Univ. (Bias voltage:80V, Charge carriers: holes)