§32. Gamma-ray and Neutron Diagnostics by Used of a Small Semi-conductor Detector in Laser Fusion Experiment

Isobe, M.,
Kaneko, J.H., Kakimoto, A. (Hokkaido Univ.),
Nakai, M., Azechi, H. (I.L.E., Osaka Univ.),
Krasilnikov, A.V. (TRINITI, Russia)

The neutron time-of-flight (ToF) detector system, so-called MANDALA consisting of many plastic scintillators (> 800 channels) coupled to photomultipliers has been employed to evaluate the fuel ion temperature through the measurement of energy spectrum of neutrons produced by fusion reactions at Institute of Laser Engineering Osaka University [1]. Because g-/X-rays reach the detector earlier than neutrons, a signal pulse due to neutrons can be discriminated from that produced by g-/X-rays in the detection timing. In the fast ignition experiment, however, because of huge flux of prompt X-rays, X-rays produced large pulse masks neutron pulse and in consequence, it is hard to pick up a neutron pulse. Therefore, it is worthwhile to explore an alternative neutron detection method. A natural diamond detector (NDD), which have been applied to the Large Helical Device (LHD) to diagnose energy distribution of fast neutral particles originating from neutral beam heating and/or ion cyclotron resonance heating [2,3], is one of possible candidates for the ToF neutron detector. The diamond itself is known to be fast in time response and has very thin body. Therefore, neutron pulse may be distinguished from X-ray-produced pulse in laser fusion experiments.

We applied two natural diamond detectors (NDDs) to the laser fusion experiment in October of FY2006. One NDD, which was fabricated in TRINITI, Russia, has area of f2 mm and thickness of 0.1 mm. Another is a commercial product by D-RAD International Inc. and has a rectangular body of 3 mm × 1 mm × 1 mm thick. In the experiment of 2006, the NDD's output signal was fairly small. In order to apply a larger area/volume detector for a next opportunity, we have started to develop the detector based on artificial diamond. We purchased five artificial CVD diamonds (10 mm × 10 mm × 0.5 mm thick (×1), 5 mm × 5 mm × 0.5 mm thick (×4)) produced by Element Six. TiC/Au is used as an electrode to make ohmic contact with the diamond semiconductor substrate. Figure 1 shows a photograph of an artificial diamond detector of trial fabrication. In this test, we used the diamond of 5 mm × 5 mm × 0.5 mm thick. In order to check characteristics of time response of this diamond, the irradiation test by use of alpha particles emitted from 241-Am source was carried out in a vacuum environment. Figure 2 shows time traces of output signal from the tested artificial diamond. Bias dc voltage of +250 V/-250 V was applied. The rise time of signal is relatively longer that we expected and is evaluated to be roughly 40 ns. The other diamonds are going to be tested in the same manner. Also, a test by use of UV pulse laser (Nd:YAG/5th harmonic wave) will be performed to evaluate precise value of the rise time of signal.

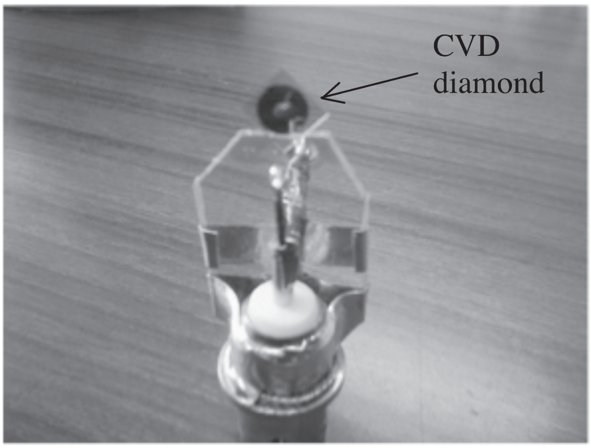

Figure 1 Particle/radiation detector based on a CVD diamond.

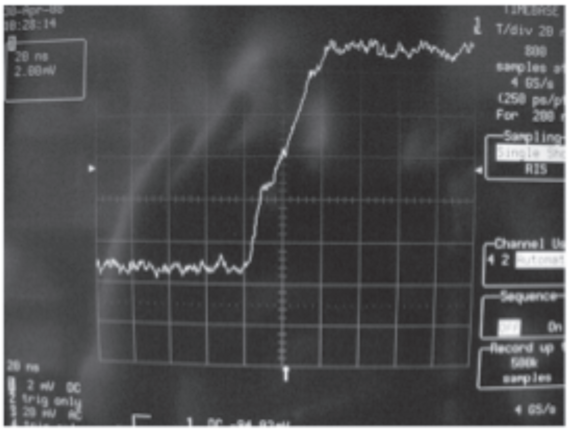

Figure 2 Time response of diamond detector when we irradiate the detector with alpha particle. The bias voltage is +250 V. Irradiation is carried out in the vacuum environment

1) Izumi, N., *et al*., Rev. Sci. Instrum. **70**(1999)1221.
2) Isobe, M., *et al*., Rev. Sci. Instrum. **72**, (2001) 611.
3) Nishimura, H., Isobe, M. *et al*., Plasma Fusion Res. **2**, (2007) S1075.