§36. Natural Diamond Detector for Neutron and γ-ray Measurements in Laser Fusion Experiments

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1. Introduction

Natural diamond detectors (NDD) have been applied to the Large Helical Device to diagnose energy distribution of fast neutral particles originating from neutral beam heating and ion cyclotron resonance heating [1,2]. Because the diamond detector is known to be fast in time response, it may be applicable to neutron and γ-ray measurements in laser fusion experiments based on time of flight technique. In this report, NDD we have developed and electronics planned for laser fusion experiments are briefly described.

2. Operation and properties of NDD

Figure 1 shows a NDD prepared for this work. NDD with ohmic Au contacts and a DC bias can serve as a radiation detector. Two different NDDs have been prepared. Both detectors have the sensing area of ϕ2 mm. One and another have the thickness of 0.1 mm and 0.2 mm, respectively. The signal generation process is basically similar to that of a Si semiconductor detector. In the case of the high energy photons, electron-hole pairs are created by photoelectric events. In the case of neutrons, a variety of nuclear processes such as elastic and inelastic scattering $^{12}C(n,n')^{12}C$, nuclear reaction $^{12}C(n,\alpha)^{9}Be$ and so on are involved [3]. The important properties of NDD in comparison with a Si detector include a high band gap of 5.5 eV, short mean free drift time of ~10 ns, large saturation carrier velocity of 2.2×10^{7} cm/s for E of 10^{4} V/cm), high breakdown voltage of 10^{7} V/cm. Further detailed descriptions of NDD's properties are available in Ref. 3 and 4.

3. Electronics

Figure 2a) shows the electronic circuit used for neutral particle measurement in LHD. This system is suitable for measurement of energy spectrum of detected particles through pulse height analysis but it is slow in time response. Because the time response of GHz range is required in the laser fusion experiment, the circuit used in LHD can not be used for this purpose. In order to enhance time response as much as possible, we will use a circuit shown in Figure 2b). A high voltage bias-T (Picoseconds Pulse Lab./Model : 5531) resistively couples the signal cable to a high voltage power supply and capacitively couples the signal cable to a GHz sampling oscilloscope.

4. Plan in next fiscal year

We have so far developed thin NDD in anticipation of ultra fast response and have prepared necessary electronics used for this experiment. In next, first we will check total bandwidth of this system by use of ultraviolet laser with pulse width less than 1 ns. After this check, NDDs will be applied to laser fusion experiments in I.L.E. Osaka University.

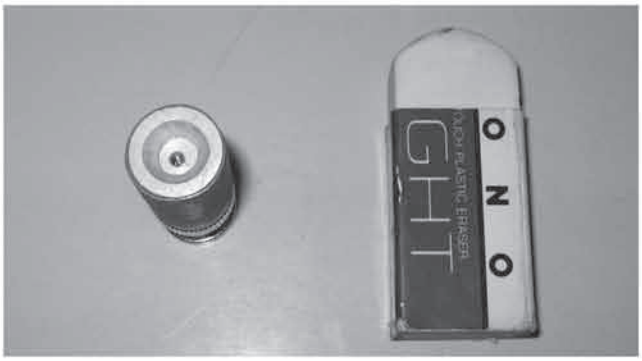

Fig. 1. Photograph of natural diamond detector. It has a size of ϕ2 mm and 0.1 mm thickness. Surface electrode is made from Au.

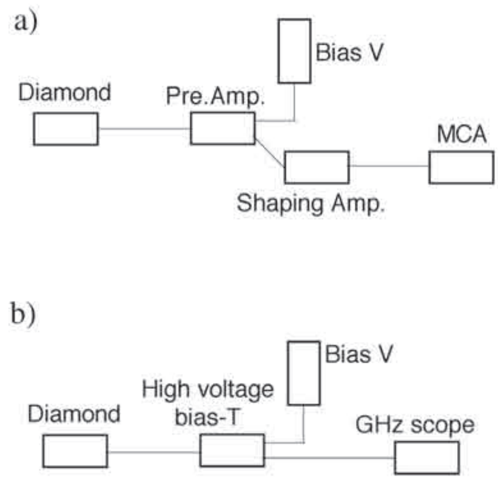

Fig.2 a) Electronic circuit used for fast neutral particle measurements in LHD [1]. b) Circuit planned for laser fusion experiment in ILE Osaka University.

References

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