EDP1-8

Develipment of STJ with large detection area for neutron detector

*Kai Kudo[1], Masahiro Ukibe[2], Chiko Otani[3], Masato Naruse[1], Hroaki Myoren[1], Tohru Taino[1]

Saitama University Japan[1]
AIST Japan[2]
RIKEN Japan[3]

Since neutron is permeable to metals and sensitive to light elements such as hydrogen, lithium and boron, it can nondestructively evaluate a bulk texture of metallic materials. Therefore, it has been expected as a new imaging tool in the industrial fields such as automobile industry and construction industry and so on. However, conventional neutron detectors can realize indeed a large sensitive area (> cm^2), but they only have poor spatial resolution of the order of millimeters. On the other hand, superconducting tunnel junctions (STJs) on a single crystal $Li_2B_4O_7$ (LBO) substrate have proposed as a next generation neutron detector because of its high detection efficiency [1]. In case of STJs, a high spatial resolution (< 50 mm) can be possible but it is fairly difficult to satisfy the required sensitive area (10 cm × 10 cm) of the detector for industrial applications, because the area of single STJ is limited to 0.1 mm × 0.1 mm due to its own characteristics and then at least 1 million pixels are necessary to cover the whole required sensitive area, which leads to a quite large heat load to cryostats through 2 million wires. That is not realistic. Therefore, it is necessary to introduce another approach for realizing such a large sensitive area and a high spatial resolution, simultaneously.

In this research, we proposed and fabricated a new substrate absorption type STJ for neutron detection with 1 pixel size of 5 mm × 5 mm, which can be expected to achieve large detection area by using a small number of STJs. Fig. 1 shows our proposed neutron detector. Neutron is irradiated from the substrate. 4 STJs detect phonons generated in the substrate by nuclear reactions of neutron with Li and B. Theoretically, the position of the neutron absorption can be determined precisely from the each pulse height of STJ[2]. The geometric configuration of STJs should be decided to realize a high special resolution as well as a large detection area. In order to determine the above configuration, it is necessary to evaluate the phonon diffusion length in the substrate. As a first step, we have tried STJs on LBO substrates and determined the phonon diffusion length to design the appropriate neutron detector based on STJs. The fabrication method and the evaluation results will be presented.

[1]T.Nakamura et al., Nucl. Instr. and Meth.,m A 529, 402-404 (2004).
[2]H.Kraus et al., Phys Lett. B 231, 195 (1989).

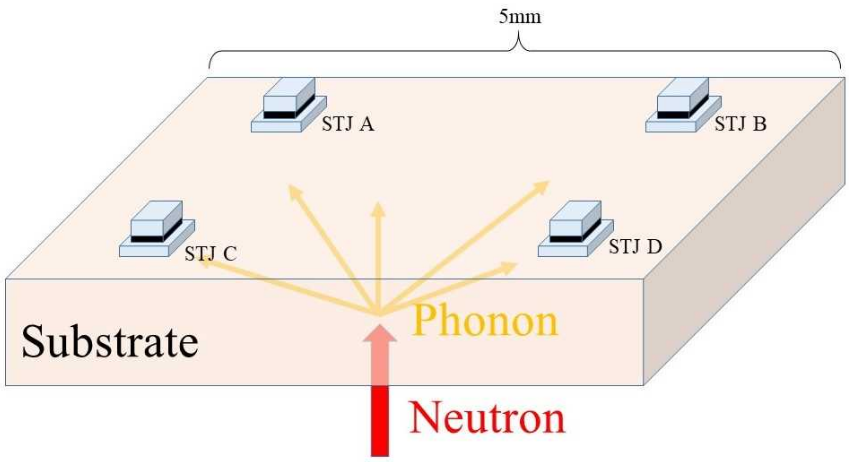

Fig.1 Our proposed neutron detector

Keywords: Superconducting Tunnel Junction, Neutron detector