§18. 14-MeV Neutron Irradiation Effects on Superconducting Magnet Materials under Cryogenic Temperature

Nishijima, S. (Osaka Univ.), Nishimura, A., Nishijima, G. (Tohoku Univ.), Izumi, Y. (Osaka Univ.), Ochiai, K. (JAEA)

Introduction

One of the most important features of radiation environment surrounding nuclear fusion devices is the energy of fusion neutron, whose maximum energy is 14 MeV. Therefore, the effects of 14 MeV neutron irradiation onto fusion devices, especially superconducting magnet materials, are intriguing issues to realize nuclear fusion reactor system. However, until now, nuclear reactor has been main source of neutron in the field of irradiation effects. The energy spectrum of neutron in the fission reactor, in which the average neutron energy is about 2 MeV, is much different from that of fusion neutron. In this report, 14 MeV neutron irradiation effects of insulating materials were studied.

Experimental

GFRP and mono-dispersed polystyrene were irradiated at an ambient temperature with 14 MeV neutron generated from FNS installed in JAEA, Tokai. For comparison γ-irradiation was also performed using ^{60}Co γ-rays at ISIR, Osaka Univ. The irradiated and non-irradiated polystyrene samples were dissolved into THF, and then molecular-weight distributions were analyzed by using GPC. Interlaminar shear strength (ILSS) of irradiated and non-irradiated GFRP was measured as shown in **Fig. 1**.

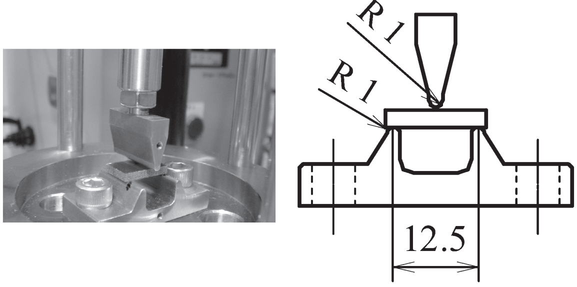

Fig. 1 The apparatus and set-up of specimen to measure the interlaminar shear strength of GFRP.

The capacity of mechanical test machine was 10 kN. Test conditions were as followings; thickness/span = 5.0, stroke rate = 0.75 mm/min, temperature: RT and 77 K, and sampling rate: 50 Hz.

Results and Discussion

Figs. 2 and **3** show the ILSS of neutron and γ-irradiated GFRPs, respectively. Based on the dose conversion of $2.3\text{x}10^{15}$ n/m^2 = 1 Gy, a neutron fluence of 3.91 x10^{19} n/m^2 is equivalent to 0.017 MGy. This corresponds to low dose region in **Fig. 3**, and no significant degradation in ILSS was observed. On the other hand, as shown in **Fig. 3**, γ-ray has potential to decrease ILSS. ILSS at 77 K decreased more efficiently than at RT.

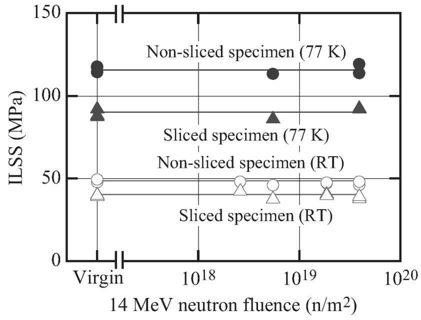

Fig. 2 ILSS of 14 MeV neutron irradiated GFRP.

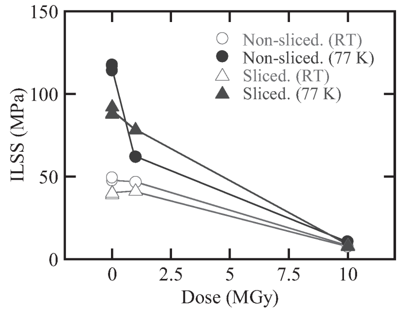

Fig. 3 ILSS of γ-irradiated GFRP.

In order confirm the difference in irradiation effects of polymeric materials between 14 MeV neutron and γ-rays, we examined the irradiation effects of polystyrene, which is one of the most typical aromatic polymers, and the results are shown in **Fig. 4**. Comparing to g-irradiated samples, 14 MeV neutron irradiated polystyrene seem to form new shoulder peaks at both side of high- and low-molecular weight. This phenomenon indicates the strange heterogeneous reaction from γ-irradiation can occur, in case of neutron irradiation. And this result suggests that recoiled atoms, H or C might play a role like high LET radiation.

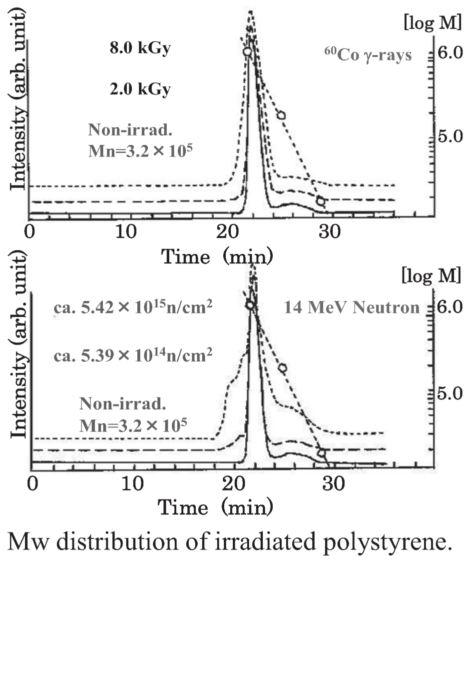

Fig. 4 Mw distribution of irradiated polystyrene.