§19. Magnetization of Neutron Irradiated Nb_3Sn Strand

Nishimura, A.,
Li, D.X., Watanabe, K., Shikama, T. (Tohoku Univ.)

The fusion reactor will generate a lot of fusion neutrons with 14 MeV energy and some of these neutrons will stream out of the plasma vacuum vessel and reach the superconducting magnets. The superconducting properties of the conductor will be changed by the neutron irradiation, therefore, the magnetization properties of Nb_3Sn strand was investigated by SQUID installed at radiation control area at Oarai center, IMR, Tohoku University. This report will present some results.

The Nb_3Sn sample tested was provided by Furukawa Electric Co., Ltd. It is a bronze-root strand and the diameter is 0.7 mm. The samples of about 45 mm long were irradiated at JRR-3 to 1.0 x 10^{21} n/m^2 and 1.0 x 10^{22} n/m^2 by over 0.1 MeV neutrons. The temperature during the irradiation was kept to be around 100 C. After the irradiation, small samples of about 3 mm long were cut out of the irradiated samples and used for SQUID testing.

The magnetization properties were measured with Magnetic Property Measurement System (MPMS-5, Quantum Design Inc.) installed at Oarai center of IMR.

The M-H diagrams of the Nb_3Sn samples are shown in Fig. 1. By neutron irradiation, M-H hysteresis was expanded and it means that the critical current improves.

Magnetization results against temperature of non-irradiated and irradiated are shown in Fig. 2 to Fig. 4. The critical temperature at 0.005T decreases after 1.0 x 10^{22} n/m^2 irradiation. At the same time, significant shift of the magnetization to diamagnetic was observed in the normal conducting state under higher magnetic field and it is amplified by inducing neutron irradiation damage. Copper is diamagnetic and the shift of the magnetization would be caused by change in the property of the copper. The further study is continued to understand the irradiation effect.

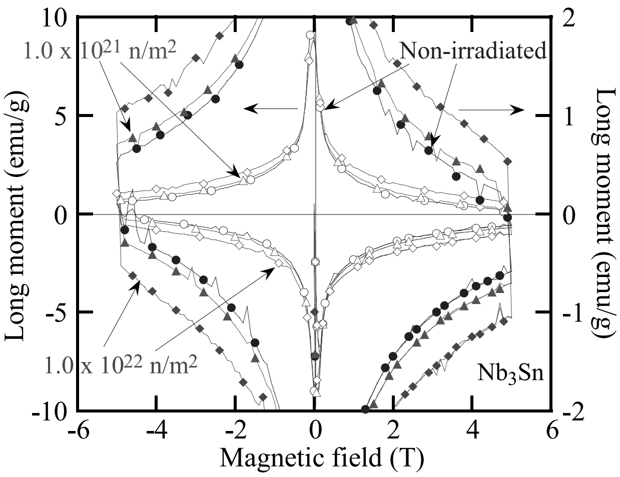

Fig. 1. M-H diagrams of non-irradiated and irradiated samples at 4.2 K.

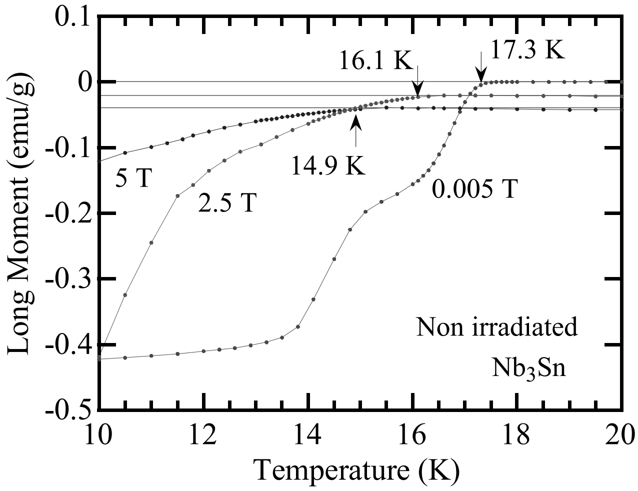

Fig. 2. Magnetization against temperature of non-irradiated Nb_3Sn strand. Small shif to diamagnetic is caused by copper.

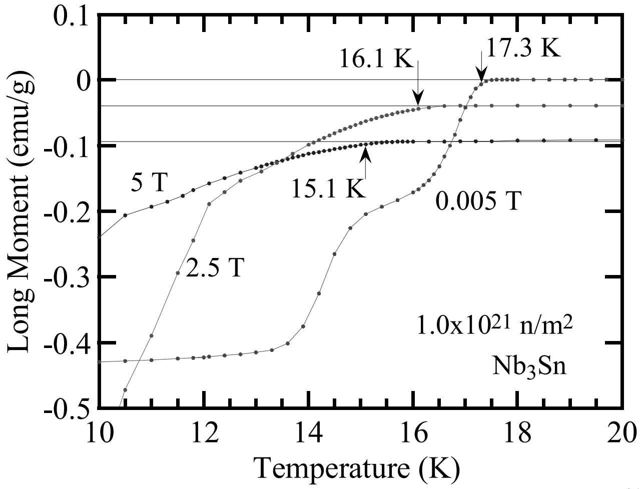

Fig. 3. Magnetization against temperature of 1.0 x 10^{21} n/m^2 neutron irradiated. The shift to diamagnetic becomes larger by irradiation.

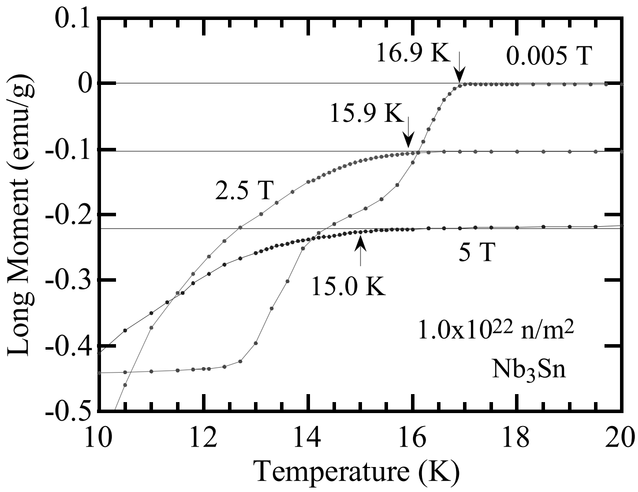

Fig. 4. Magnetization against temperature of 1.0 x 10^{22} n/m^2 neutron irradiated. The shift to diamagnetic is amplified by irradiation.