§102. Neutron Irradiation Effect on Superconducting Magnet Materials for Fusion

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The results in 2012 showed the temperature rise of the sample holder occurred when large current was put in the sample. In order to make the phenomenon clear, the sample holder was newly fabricated with the materials certificate and the new Nb_3Sn strand was prepared. The set-up was carried out carefully and the test was performed under self-field at around 4.3 K.

Figure 1 shows the results of the electric current test under 500A/50sec ramp rate which was carried out in 2012. When the current over 100 A was put in, the temperature of the sample holder increased significantly. In 2013, the pure copper with over 99.96% purity (JIS C1020, Oxygen Free Copper) was used for the sample holder and pre-heating was carried out to wet the copper surface perfectly when the sample was soldered. The high power (100 W) solder equipment was used. After soldering, the contact surfaces with bas bars were polished using sand papers to remove the oxide layer. Apiezon grease was not used for the interface to avoid the additional electric resistance. The attached surfaces were contacted mechanically with 8 bolts. The soldered sample holder is shown in Fig. 2. Four wires were attached on the sample to measure the center voltage with four-probe method. The temperatures of + and – electrodes were measured by type CU CERNOX. Although the high temperature superconducting tapes which were attached on the high purity aluminum rod for cooling the holder were not in good condition, the tapes were not replaced because the typical test results were expected. The HTS tapes were fixed with kapton tapes.

The sample holder and current leads were cooled down by GM refrigerator. The temperature at the sample holder was controlled at around 4.3 K. The current was put in the sample at a certain ramp rate. The typical results are shown in Fig. 3. The test was carried out under self-field and the ramp rate was 500A/50sec. When the current was increased up to 500 A, the temperature rise of the holder was very small (the initial temperature was 4.35 K and the final temperature at 495 A was 4.51 K) and the sample voltage at the center was about 0.1 μV at 495 A showing the sample is superconducting. From the results, it would be concluded that the sample temperature would be kept on around 4.2 K and no significant change in sample voltage.

The performance of the variable temperature insert and the control system was checked when the system was installed in 2010. In 2013, the preparation processes of the sample and the control and the data acquisition systems have were checked carefully and the performance of the experimental system was confirmed totally. The cooling ability of the sample holder is enough and is able to keep the sample at around 4.5 K.

Meanwhile the high-speed data acquisition system was prepared with a LabVIEW software and the reliability of the data acquisition system was improved. Since the test system was design for the activated samples, the system is expected to be used frequently for the investigation on the irradiation effect of the superconducting strand.

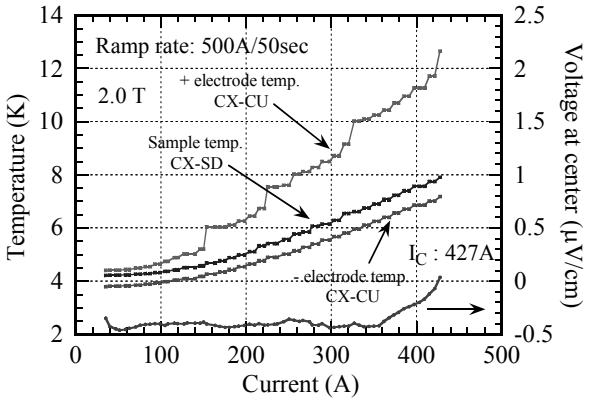

Fig. 1. Test results of Nb_3Sn strand under 2.0 T. Ramp rate was 500A/50sec

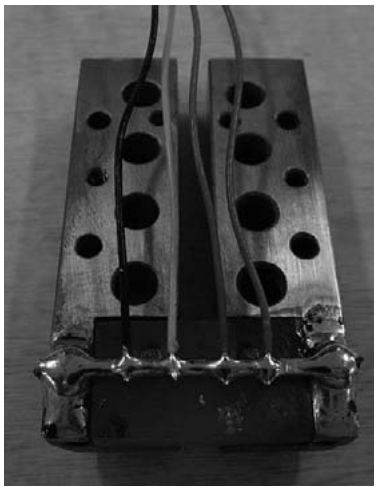

Fig. 2. Set-up status of Nb_3Sn strand on sample holder. A new Nb_3Sn strand was used.

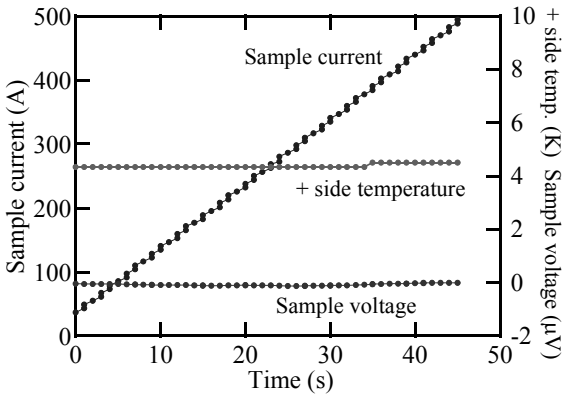

Fig. 3. Test results of Nb_3Sn strand under 0.0 T. Ramp rate was 500A/50sec. No temperature rise was observed.