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WISE導体の電流導入部改良と磁場中での通電試験

Development of current feed structure of WISE conductor and energization test in a magnetic field

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Applying high-temperature superconducting (HTS) conductors to the magnets of helical fusion reactors, the National Institute for Fusion Science has been fabricating and studying HTS conductors based on several concepts. The WISE (Wound and Impregnated Stacked Elastic tapes) conductor used in this study [1] has the features of strain-free winding [2] and fewer restrictions on magnet coil manufacturing. It is necessary to investigate the effect of critical current values in a high magnetic field that simulates the operating environment of a fusion magnet. A U-shaped WISE conductor with a total length of 2 m was fabricated by connecting HTS tape inside an aluminum pipe to an oxygen-free copper current feeder (Fig. 1), and energization tests were conducted under B = 5 - 8 T and T = 30 - 50 K. The results showed that I_c = 10.8 kA@40 K, 5 T [3, 4]. On the other hand, a maximum current value of 16.9 kA was recorded at T = 30 K and B = 5 T. However, the HTS tape burned out inside the current feeder before reaching the critical current value. The HTS tapes were connected to the oxygen-free copper current terminal by low-melting-point metal impregnation, and it was thought that the cause of the burnout in the current feeder was the distortion caused by the manufacturing process because the aluminum pipe was not sufficiently fixed. In order to ensure sufficient fixation strength, the structure was integrated as shown in Fig. 2, and a copper pipe was used instead of the anodized aluminum pipe to secure the current path during the quench, and the energization test was conducted again. As a result, a maximum current value of 19.7 kA was obtained under 20 K and self-magnetic field conditions as shown in Fig. 3 (a). No voltage appeared in the superconducting conductor part, indicating that the superconducting state is maintained (Fig. 3 (b)). However, the current feeder voltage on the anode side increased rapidly (red line Fig. 3 (c)), and the temperature increased from 19 K to 34 K from t = 201 s to 203.5 s. The connection between the normal conductor and the superconductor in the current terminal section needs to be further investigated.

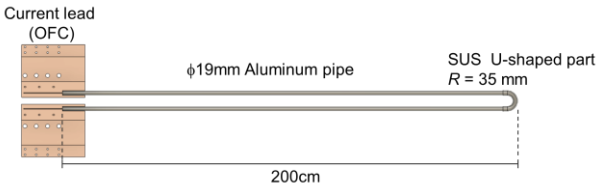

Fig.1 Overview of WISE-U conductor

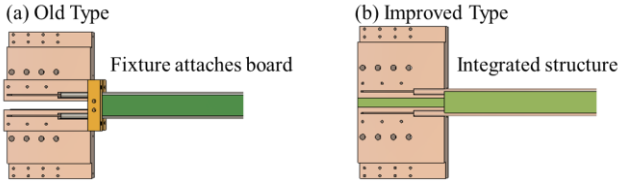

Fig.2 Previous WISE conductor (a) and developed WISE conductor (b). The WISE conductor is firmly anchored to the current leads.

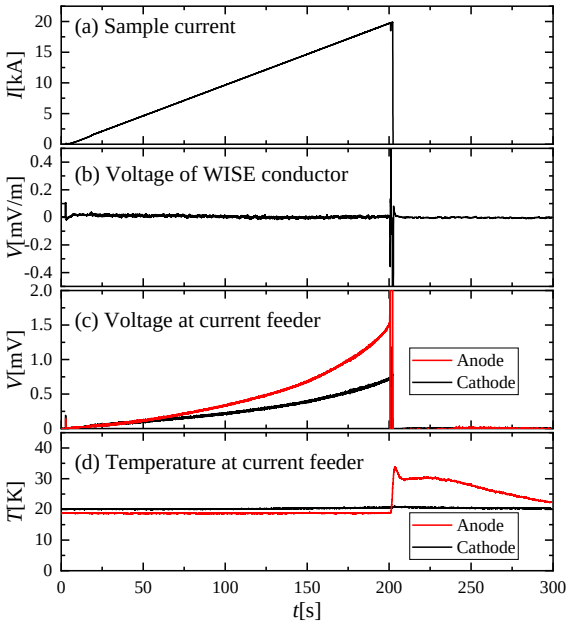

Fig.3 Time evolution of (a) sample current, (b) voltage of WISE conductor, (c) voltage at current feeder, and (d) temperature at the current feeder. The current feeder on the anode side has been burnout.

[1] 宮澤順一 他 特許第 6749541 号

[2] N. Narushima, et al.: PFR, Vol. 15 (2020) 1405076

[3] N. Narushima, et al.: Abstracts of CSSJ Conference, Vol. 102 (2021) 1A-a03

[4] N. Narushima, et al.: PFR, Vol. 17 (2022) 2405006