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高磁場試験装置における高温超伝導10kA級WISE-U導体試験
Test of 10kA class HTS WISE conductor in high magnetic field facility

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High temperature superconducting (HTS) conductors are one of the candidates to fabricate magnets for the next generation helical fusion devices because of its likelihood of temperature margin comparing to the low temperature superconducting (LTS) and higher critical current in a high magnetic field. The HTS-WISE (Wound and Impregnated Stacked Elastic tapes) conductor is a concept in which stacked HTS tape wires are bound with metal spiral tubes and impregnated with a low-melting-point metal after coil winding. Owing to the post-winding impregnation, the coil making is more flexible than that of conventional HTS conductors. In this study, the U-shaped WISE conductor named WISE-U is fabricated as shown in Fig.1.The total length of the WISE-U is about 2 m. The conductor jacket is made of aluminum with an outer diameter of ϕ19 mm. The tip is a U-shaped stainless-steel pipe with a radius of curvature R = 35 mm, which allows the superconducting conductor section to be free of connections that contain normal-conducting resistance. The current introduction section is connected to a block of OCF (oxygen-free copper). The magnetic field and temperature dependence of the critical current value is shown in Fig. 2. It should be noted that the experimental data at T = 30 K (triangles) do not represent the *critical current* but the *maximum achievable* current. At T = 50 K (squares), the critical currents of I_c = 5.4 kA (B = 8 T) to I_c = 6.3 kA (B = 5 T) are obtained, and I_c = 8.1 kA (B = 8 T) to I_c = 10.8 kA (B = 5 T) are obtained at the lower temperature T = 40 K. The maximum current of 16.9 kA is obtained at T = 30 K and B = 5 T without quenching of the superconducting part, while the HTS tapes embedded in the current lead is burned out. The 16.9 kA corresponds to the current density of j = 60 A/mm^2. As a fusion magnet that carries a large current in a magnetic field, the ability to withstand EM (electromagnetic) forces is one of the most important factors. Figure 3 shows the EM force that he WISE-U experiences in the magnetic field. The maximum EM force reaches F = 131kN/m (13.4tw/m) for T = 30K and B = 8 T, however the WISE-U is able to withstand the EM force.

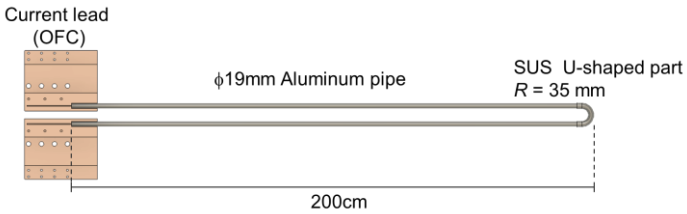

Fig.1 Overview of WISE-U conductor

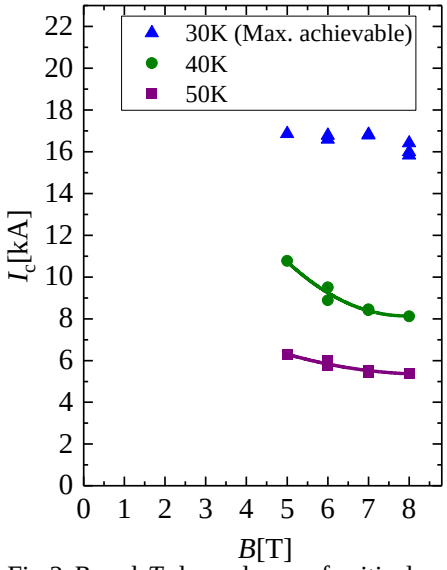

Fig.2 B and T dependence of critical current I_c (Square 50K and circles 40K) and maximum current (triangles 30K)

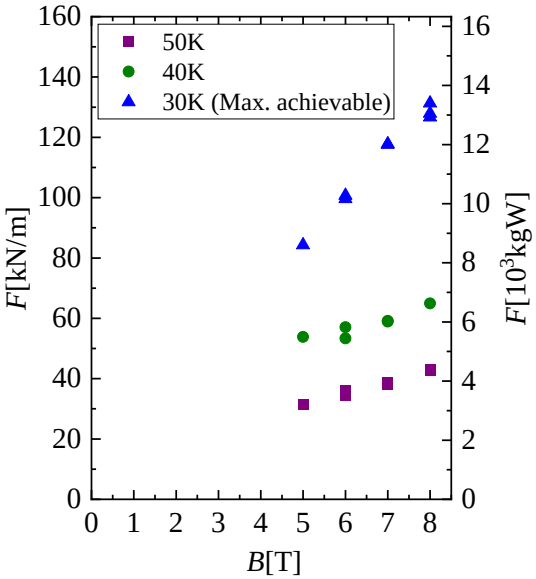

Fig.3 Electromagnetic force WISE-U experiences in magnetic field.