§4. Electromagnetic and Structural Investigation of Inter-strand Resistance in CIC Conductor for Fusion Magnets

Yagai, T., Hamano, K., Yoshida, K. (Sophia Univ.), Obana, T.

JT-60SA has been constructed as a device for the complement of parameters of fusion reaction being used in the ITER (International Thermo nuclear Experimental Reactor) project. The equilibrium field (EF) coil in the device is used for controlling position and shape of plasma by pulsed or non-steady-state feeding currents. In this aspect, the coil operation needs accurate current distribution which satisfy the minimum error magnetic field and low ac losses to reduce the load to the cryogenic system. In this aspect, we investigated experimentally the inter-strand contact resistance inside the sample EF conductor with 145 mm in length and 3D locations of each strand to obtain the contact frequencies along the conductor axis for the analysis of electric circuit network inside the conductor.

Figure 1 shows the measured inter-strand contact conductance inside the sample conductors for EF-L, EF-H conductors. [1]

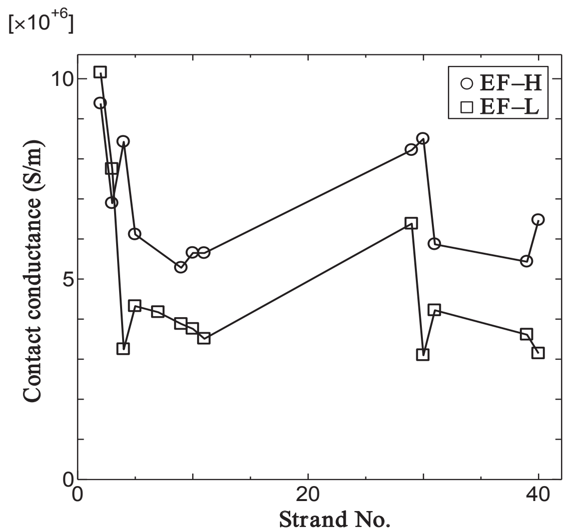

Fig. 1. Measured contact conductance for various combinations of strands. The numbers on the horizontal axis are proportional to the distance between a pair of strands.

In this figure, it is indicated that relations between the distance of a pair of strands and conductance are not straightforward. In other words, distance between strands has no importance to determine the contact conductance.

The conductor consists of multi-staged sub-cables in which the superconducting strands and Cu wires are twisted. Therefore, contact crossover of pairs of strands would be periodically appears. The important things are how often the crossover appears along the longitudinal direction of the conductor and dependency of its interval.

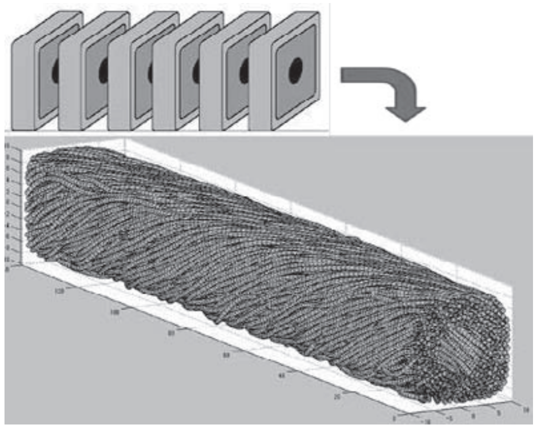

Fig. 2. Experimentally obtained strand traces of EF-L conductor of JT-60SA.

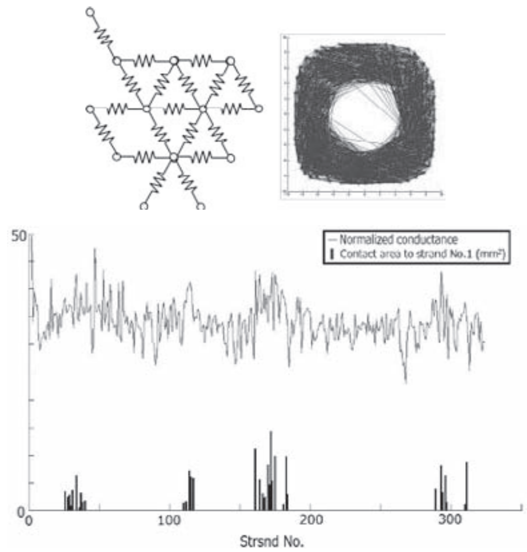

Fig. 3. Contact conductance vs. the number of strand (i.e. distance between strands). The bar graph indicates the calculated area of the contact crossover.

To evaluate the contact frequencies inside the conductor, we measured the strand traces of EF-L conductor. The three dimensional strand traces are shown in Fig. 2. The strands would be tangled each other and consequently the internal structure is very complicated. By using these traces, we calculated the contact conductance distributions based on the static electric, two-dimensional circuit model as shown in Fig. 3. In the static model, resistances along strands are all negligible, which enables us to reduce the dimension of the circuit model. The calculation in Fig. 3 showed that the actual contact surface would play an important rule to increase the conductance. The results indicate that the current distribution would have strong dependence of the contact surface and contact frequencies. To evaluate the current distribution, measuring the strand traces plays a crucial rule for the detail calculation of that.

1) Hamano, K.: ISS2013, SAP-04, 2013.