§ 16. Electromagnetic Stress and Coupling Loss in Superconducting Cable

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When we evaluate coupling loss in cable conductors, not only the coupling loss in a single strand but also the loss occurred by a current loop including some strands is important. So, we measured contact resistance, which is one of main parameters for the coupling loss including some strands, under various contact force and deformation of the strands.

Fig. 1 shows an experimental arrangement. As described in the figure, two-straight strands are horizontally placed with an intersecting angle, and compressive force is applied to a crossing point of the two strands (maximum force is more than 100 newtons). We used two kinds of superconducting strands whose diameters are 0.25 and 0.39 mm. The contact resistance was measured by a typical four-wire method. At the same time as measuring the contact resistance, the applied force and the deformation of the strands were detected with a load cell and a clip gauge respectively.

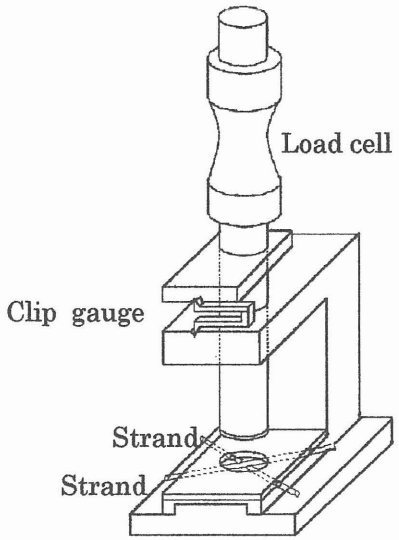

Fig. 1. Schematic illustration of experimental arrangement.

Experimental results at liquid nitrogen temperature are shown in Fig. 2. In spite that the two different strands were used, those contact resistances against applied force were almost same values, and the resistances decreased with increasing of the applied force. On the other hand, the deformation of the strands versus the applied force showed different profiles because the hardness of the strands was not same due to different copper ratios in the strands.

A contact area was calculated based on the deformation of the strands, the measured force to the strands was transferred to stress, and surface resistance was estimated from the measured contact resistance. Fig. 3 shows the estimated results. From Fig. 3, in spite of the wide range of the applied force to the strands, values of the surface resistance are in the range of $4\times10^{-11}\sim1\times10^{-10}\,\Omega\,m^2$.

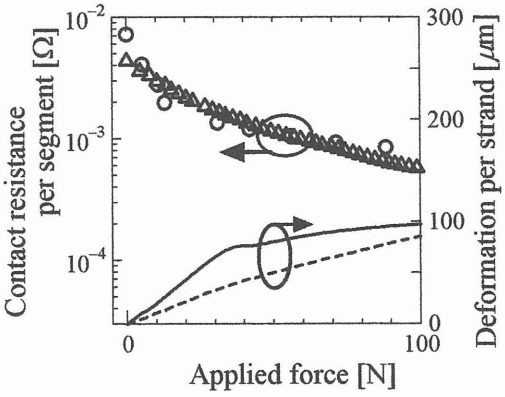

Fig. 2. Measured data of contact resistance and deformation (○: 0.25mm, △: 0.39mm, solid line: 0.25mm, dashed line: 0.39mm).

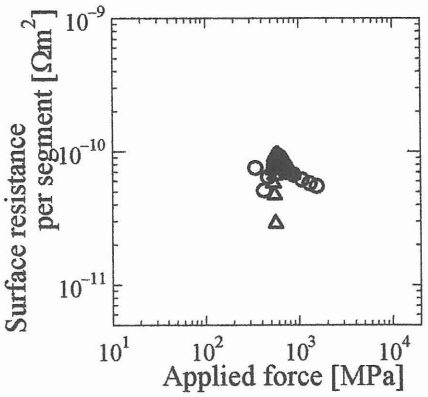

Fig. 3. Evaluated results of surface resistance.

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