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Current dependence of contact resistance value in superconducting busbars
超伝導ブスバーにおける接触抵抗値の電流値依存性

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We discover that contact resistances in superconducting busbars depends on the current. At the connection resistance measurement of a conductor of the ITER-TF coil.. We simulate to explain the special behavior and succeed in obtaining a result to agree with the experimental value to use a parallel circuit model.

1. Introduction

Superconductors have been used for magnets, busbars and others in fusion research device.

The connection resistance of ITER toroidal field coil conductors were measured by a large conductor examination device at NIFS. On this occasion, we use superconducting busbars for reduce heat of copper busbars. We measure currents of both busbars using Rogowskii coils. As a result, we discover that superconducting busbar's contact resistance depends on the currents. Presumably, this have important significance in the application of the superconductor.

We compared the experimental result with the simulation result based on parallel circuit model and considered the reason.

2. Experimental method

Fig.1 shows busbars which are used for this experiment. HTS busbar was made by arranged 35 pieces of HTS tapes (DI-BSCCO I_c>200A@77K) to one line into the copper case bent into a U-shape and connected with eutectic solder. HTS and cupper busbars are connected in parallel with a eutectic solder. We measured each electric current using the Rogowskii coil while the examination from 0 to 68kA (@6~14K). Additionally we measured temperature and the voltage of both ends of the cupper busbars.

3. Experimental result

Fig.2 shows current-voltage property of both busbars and ratio of HTS busbar current for total current. Current-voltage property of the HTS busbar is non-linear and the slope become small with increase of current.

This means the superconducting busbar's contact resistance value depends on the current.

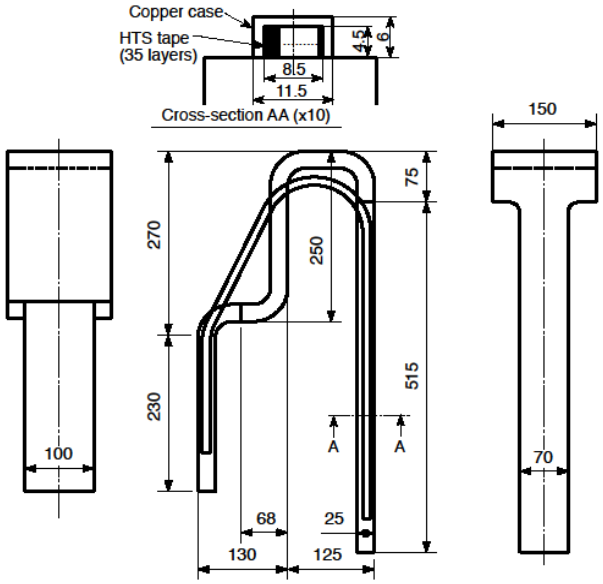

Fig.1. Schematic illustration of cupper and HTS busbar

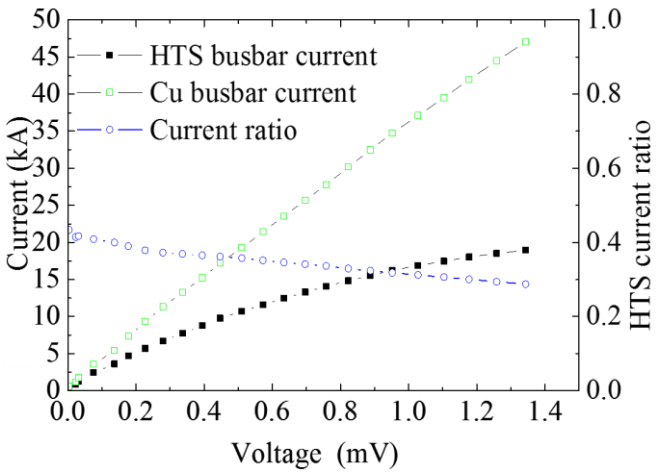

Fig.2. Current-voltage property of both busbars and ratio of HTS busbar current for total current

4. Simulation model

We simulate to explain the relationship of current and contact resistance using simulation model as shown in Fig.3.

In this model, we assume it as follows.

1. HTS busbar regard as parallel circuit through contact resistance $R_{//}$,$R_{\perp}$.
2. $R_{//}$ and $R_{\perp}$ is constant.
3. Current divide flow directly from cupper busbar current ($I_{//}$) and flow through widely plane of cupper case current ($I_{\perp}$).
4. $I_{\perp}$ flows to most outside HTS tape until $I_{\perp}$ reach I_c and then $I_{\perp}$ after having reached I_c, $I_{\perp}$ becomes flows next outside HTS tape.
5. I_c is defined by a as follows function proposed by Y.B.Kim[1] and assume it to satisfy existing data[2,3]

$$I_c = \frac{\left(1-\frac{T}{T_c}\right)^{\alpha}}{\left(1+\frac{B}{B_0}\right)^{\beta}}$$

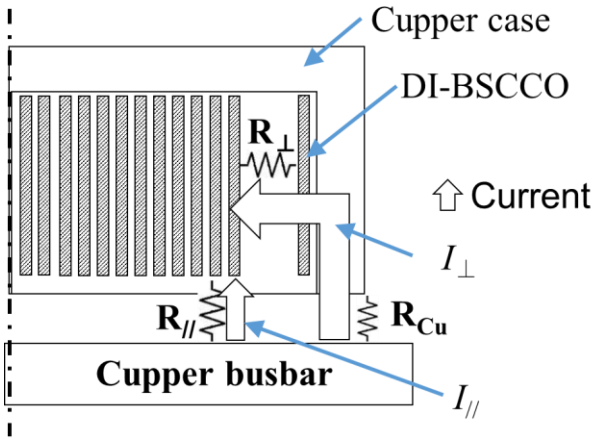

Fig.3. Schematic illustration of Simulation model

5. Simulation result

Fig.4. shows simulation and experimental result of the HTS busbar's current-voltage property. Simulation result accords with experimental well except high current domain. Presumably, the gap of high current domain means I_c becomes smaller than an assumption for bending or mutual inductance effect and so on.

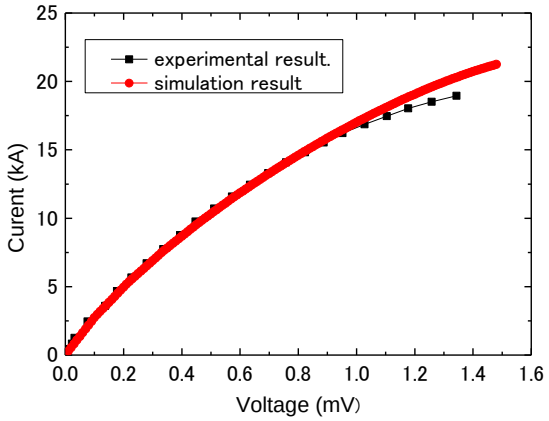

Fig.4. Simulation and experimental result of the HTS busbar's current-voltage property

6. Summary

We discover that superconducting busbar's contact resistance value depends on the current. In addition we simulate to explain the special behavior and succeed in obtaining a result to agree with the experimental value to use a parallel circuit model. Presumably, this study have important significance in the application of the superconductor.

Acknowledgments

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References

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