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Evaluation of SUperconductive Assisted Machine (SUAM) with Superconducting Coated Wires using Finite Element Method

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Various processing methods are used including lathe processing and magnetic polishing. At the present time, it is difficult to apply the hollow processing method to complicated shapes due to the restriction of the interference of tools as machining. In order to solve these problems, we have developed SUperconductive Assisted Machining method (SUAM) using the flux pinning phenomenon of bulk superconductors as shown in Fig.1. This SUAM is composed of a single-sided four-pole permanent magnet and a superconducting bulk, and is a method utilizing magnetic levitation that occurs when cooled in a magnetic field with the permanent magnet held in the air. In this method, the superconductor receives attractive, repulsive, restoring and driving forces. In this study, we evaluate these performances of the superconducting coated wire numerically using the finite element method, and compare with the superconducting bulk at each force.

We use JMAG to calculate by FEM, and use an *n*-value model to calculate the *E*-*J* characteristics. We use the experimental result of $GdBa_2Cu_3O_{7-\delta}$ superconducting bulk for the bulk and the experimental result of $YBa_2Cu_3O_{7-\delta}$ for the superconducting wire for the magnetic field dependence of the critical current density. We bring a 450 mT permanent magnet close to the superconducting bulk or superconducting wire at a speed of 0.1 mm/s. We make the superconducting wire into a laminated structure and calculate the total force of the force received by laminating 2 μm thick superconducting 20 layers.

Fig.2 shows the difference in repulsive force between the superconducting bulk and the superconducting coated wire. The repulsive force increases as decreasing the distance to the permanent magnet. As a whole, the superconducting coated wire has a smaller repulsive force than the superconducting bulk. About the attractive force and the rotational torque, the superconducting bulk similarly gives larger force. It is considered that a larger force can be obtained by increasing the number of superconducting coated wires.

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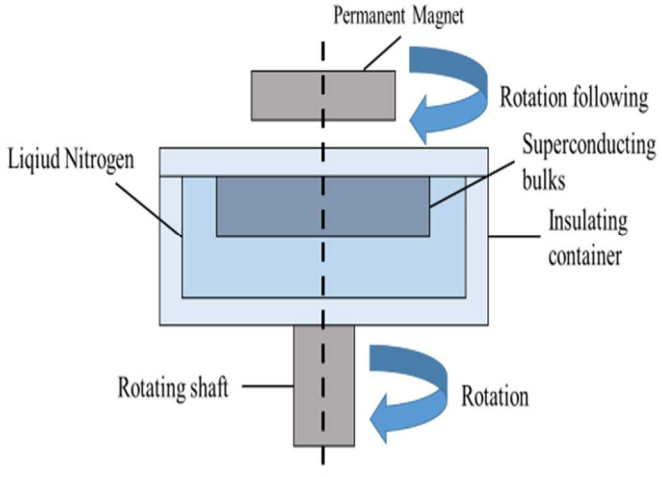

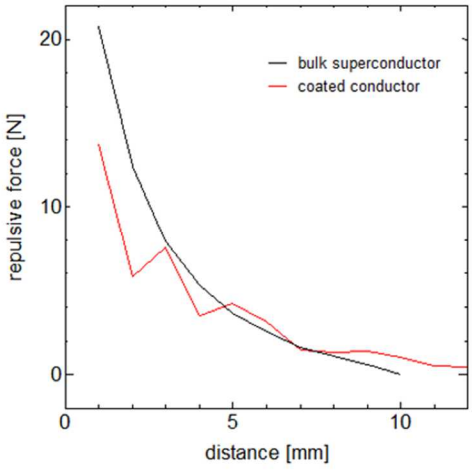

Fig.1 SUAM(SUperconducting Assisted Machine)
Fig.2 Difference in repulsive force between bulk supercondcting and coated conductor

Keywords: FEM, SUAM, magnetic levitation, coated conductor