2G HTS coil Stability Improvement via V_2O_3 Material and Perforated HTS Wire

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**Background**

When we look at the results of this research so far, it is clear that the electrical stability of the no-insulation superconducting coils has improved over insulated superconducting coils. However, when being quickly charged or discharged, the no-insulation coils are difficult to control than conventional insulated superconducting coils. Because of this, we have developed a smart insulation coil which uses the metal insulator transition (MIT) properties of the V_2O_3 material so that we can overcome the disadvantages of both conventional insulation coils and no-insulation coils. However, in the case of 2G HTS coils, a problem has been discovered where current bypass does not occur smoothly due to the wire’s structural properties.

**Objectives**

We experimentally analyze and verify the current bypass path according to the structural properties of the 2G HTS wire, and we present a method which allows for smooth current bypass.

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**Conclusion**

- In this research, we presented a structure which allows the current bypass to occur easily during transient states in order to ensure the stability and reliability of a 2G HTS coil using V_2O_3.
- To verify this, we experimentally analyzed the current’s movement path between turns in the 2G HTS wire. Therefore, it was experimentally verified that the current bypass movement path in the 2G HTS coil was structured so that most of it could only flow through the copper layer.
- To supplement this, holes were bored in the wire rod, and we examined whether a single turn state occurred due to the expansion of the current’s movement path.
- The experiment results confirmed that even though there was a reduction in the Ic due to the holes, the resistance between turns was reduced by the holes, and a single turn state occurred during transient states, just as in the 1G HTS coil.
- In the experiment, we bored 1 mm holes which were not small, however there is research being performed nm - μm scale holes are created using lasers, etc. so that reduction does not occur. We expect this research will show that it is possible to create an improved structure where a single turn state occurs without a reduction in Ic.

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**MIT Characteristics and Output Characteristics of Electric Insulation Method**

**MIT Characteristic**

MIT characteristic refers to an instant change in material property from metal to insulator or from insulator to metal due to the change in the resistance under certain conditions.

Among the many materials with an MIT characteristic, oxides (01 oxide) V_2O_3 was used in this study because its temperature transition range was considered appropriate for the required conditions in the study. V_2O_3 is a material whose resistivity in a pure single crystal state sharply changes by 1/600,000 times at approximately 150-170 K.

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**Analysis of Output Characteristics**

**According to The Turn-to-turn Electrical Resistance of 1G and 2G HTS Coils Using V_2O_3**

In the case of the 2G HTS wire, its structure is layers of complex material, so the resistance of each material and the resistance of the V2O3 becomes the total turn-to-turn resistance. The 2G HTS wire’s buffer layer is made of oxides and has the specific resistance close to an insulator, so we have determined that when current bypass occurs, most of the current flows to the copper layer which is a stabilizer.

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**Comparison of resistance in sample with copper, silver and superconductor layers removed and sample without layers removed**

**Perforated 2G HTS Wire Test to Reduce turn-to-turn Resistance**

The results of measuring the short sample lc of the perforated 2G HTS wire and the results of the over current test.