DEVELOPMENT OF A REACT-WIND-SINTER PROCESS OF AG ALLOY CLAD $Bi_2Sr_2CaCu_2O_{8+X}$ CONDUCTORS

G. Merritt (NHMFL/FSU, Mech. Eng.); U. Trociewitz (NHMFL); J. Schwartz (NHMFL/FSU, Mech. Eng.)

Introduction

Ag-clad $Bi_2Sr_2CaCu_2O_{8+x}$ conductors are a primary candidate for high field superconducting magnets generating magnetic fields of 25 T and above. Manufacturing of superconducting magnets from these conductors, however, is complicated by the difficult thermo-mechanical processing required. Traditionally, two approaches have been used: React-and-Wind (R&W) and Wind-and-React (W&R). Here we present experiments aimed at a new approach, React-Wind-Sinter (RW&S). R&W is limited by the strain the conductor can tolerate during winding without degrading its performance. The W&R approach is limited by the build up of considerable thermal mass in the winding thickness of the solenoid causing thermal gradients as well as causing a slower response towards changes of temperature in the applied heat treatment profile. In the RW&S approach, the conductor is taken through the partial melt, cooled to room temperature, wound into final shape and then sintered to heal potential damage to the ceramic core and complete the reaction process.

Experimental

The Ag-clad $Bi_2Sr_2CaCu_2O_{8+x}$ conductors, provided by Oxford Superconducting Technology, were heat treated in a tube furnace. Two different wires were tested; one was a round wire with a cross-sectional area of 0.515 mm^2, the other was a rectangular wire with a cross-sectional area of 0.7313 mm^2. First, a series of conductors were heat treated using the Normal Heat Treatment Process (NHTP) developed previously, which helped optimize the temperature profile within the furnace and set a bench mark for future experiments. The second experiment, React-Pause-Sinter (RPS), consisted of separating the heat treatment into two components, the partial melt reaction stage and the sintering stage which completes the reaction. RPS experiments were to confirm that separating the heat treatment process into two steps does not adversely affect the samples. In the future, the samples will be reacted, bent to a series of varying diameters, and then sintered, to investigate if any damage induced by the bending can be healed and determine the practicality of the RW&S approach for constructing magnets. The critical current (I_c) was measured at self-field and in a 5T background field using the four probe method.

Results and Discussion

Figure 1 illustrates the I_c data. The rectangular wire has been shown to have a larger I_c than the round wire, but a lower critical current density at 5T and at self field. A 5T field typically lowers a self field Ic by 50%. Knowing this, and using the self field RPS, data it can be said that the RPS data shows little or no difference relative to the NHTP samples.

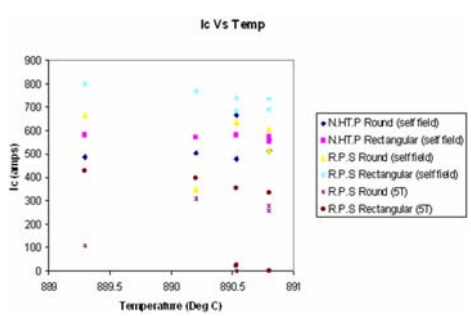

Fig. 1. Critical Current vs. Temperature

Conclusions

Although Ag-clad $Bi_2Sr_2CaCu_2O_{8+x}$ conductors have excellent electrical properties at high field, there are significant challenges for developing a viable coil technology. These experiments have confirmed that the conventional heat treatment process can be split into two steps without reductions in I_c. Future experiments will build on these results and include a bending step between partial-melt reaction and final sintering. Subsequently, the RW&S approach will be applied to small coils.

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References

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