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FABRICATION OF SUPERCONDUCTING JOINTS FOR Ag-CLAD BSCCO CONDUCTORS*

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ABSTRACT

Potential applications of high-T_c superconductors include motors, generators, transmission cables, magnets, etc. At present, resistive connections are used to connect various high-T_c components for such applications. However, to improve efficiency, it is imperative that the resistive connection be replaced by a true superconducting joint. Using a novel etching technique, we have fabricated superconducting lap and butt joints between Ag-clad BSCCO conductors. The Ag sheath from one side of the tape was selectively etched to expose the underlying superconductor core. Joints were formed by bringing the two tapes together and heat treating them. Detailed microstructural analysis and current transport measurements of the joints have been performed. Critical current (I_c) through a monofilament lap- and butt-joint were 10 and 23 A, respectively. I_c within the joint for mono- and multifilament conductors were 37 and 21 A, respectively. Additionally, effects of various joint configurations, processing techniques, and strain on the transport property of the joint are also being studied.

INTRODUCTION

Considerable progress has been made in the development of high-critical-temperature (high-T_c) bismuth-strontium-calcium-copper-oxide (BSCCO) superconductors by the powder-in-tube (PIT) technique. Two important parameters, critical current density (J_c) and conductor length, have steadily improved since the first application of this technique to high-T_c materials. J_c values as high as $\approx 1.2 \times 10^4$ A/cm^2 have been obtained in a 125-m-long monocore and an 850-m-long 37-filament conductor.[1-7]

The long-length conductors have been fabricated into pancake-shaped coils, and high-T_c magnets have been assembled from them for use in applications such as motors, generators, and medical diagnostic equipments such as that used in magnetic resonance imaging.[1-3,5,8] At present, resistive interconnections are used to join high-quality short- or medium-length conductors for coil winding and for interconnecting various parts of a superconducting device. Because the resultant Joule heating is undesirable, and the

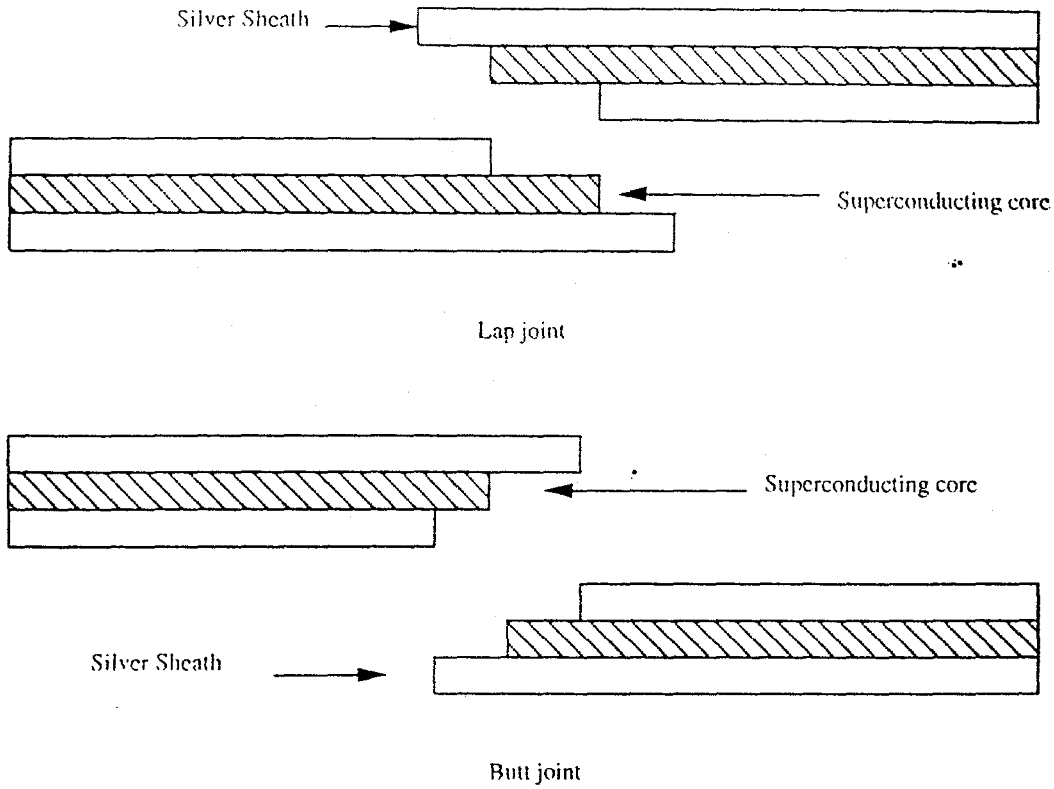

Figure 1. Schematic representation of joint formation.

Figure 2. Longitudinal cross section of lap joint, illustrating three distinct joined, transition, and unjoined regions.

I_c as a function of heat-treatment time for the lap joint and normal tape is shown in Figure 5. Initially, I_c of the joined tape is low because of incomplete formation of the joint. After 250 h of thermomechanical treatment, typical I_c within and through the lap joint was 37 and 10 A, respectively. In comparison, I_c of a normal tape (heat treated simultaneously) was 31 A. The difference in I_c through and within the joint can be attributed to the difference in thickness between the joined and unjoined regions of the tape. During uniaxial pressing, the thickness difference causes nonuniform distribution of stresses. Because the joined region suffers more reduction than the unjoined region, the transition region between the two becomes sheared. Large transverse microcracks (Figure 6) are formed in the transition region. This in turn results in degradation of current transport through the joint.

Figure 6. SEM photomicrograph of lap joint showing microcracks in transition region.

Figure 7. SEM photomicrograph of butt joint after 250 h of heat treatment.

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