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Fabrication of Cold−rolled Ag−sheathed Bi(2223) Tapes by a Partial−melting Process

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The extensive work presented here reports a new method to fabrication of Bi−2223/Ag tapes by a partial−melting process in order to achieve good grain alignment and connection. This partial−melting process consists of three heating cycles. The green tapes require a first heat treatment at relative lower temperature in order to ensure 2212 phase forms sufficiently and prevent 2223 phase from formation. A short period of melt treatment at 860℃ for 15 minutes is applied at the second annealing. The pre−oriented 2212 phase transforms to the highly−aligned 2223 phase by sintering at 835℃ for 200h during the third heating cycle. The improvement of grain size and texture compared with the normally processed tapes has been achieved by this partial−melting process.

1. INTRODUCTION

For the intergrowth layer structures features of Bi−system superconductors, which lead to two dimensionality and strongly anisotropic properties[1,2], the phase alignment were found to be critical to the Jc of Ag/Bi–Based superconducting tapes[3,4]. The melting process has been successfully used for processing YBCO and Bi−2212 in order to achieve good grain connection and alignment. However, the melting process can not be simply used for processing Bi−2223 since it will cause 2223 phase degradation and segregation[5]. In this paper, we report a new partial−melting process to fabrication of Bi−2223/Ag tapes and discuss the results of the effects of melt treatment on microstructure and phase development.

2. EXPERIMENT PROCEDURE

The powders were prepared by sol−gel method having the cation ratios Bi : Pb : Sr : Ca: Cu = 1.8 : 0.3 : 2 : 2.2 : 3.06, and fabricated into oxide−powder−in−tube tapes of overall thickness ~0.24mm and width ~4mm. The tapes were sintered at 820℃ for 50h at first heat treatment stage. The tapes were then melt processed at 860℃ in air for 10 ~ 15min, annealed at 820℃ for 50h and cooled to room temperature. Finally the tapes were rolled to be 0.12mm thickness and sintered at 835 ℃ for 200h.

The microstructure was examined using SEM. Phases were identified by XRD and by EDS on the SEM.

3. RESULTS AND DISCUSSION

In order to avoid the irreversible decomposition of 2223 phase during the melt processing, the effective way is to prevent them from formation before melting stage. In this experiment, X−Ray diffraction studies revealed that the 2212 phase was formed sufficiently during the first heating cycle at 820 ℃ for 50h, while few 2223 phase can be identificed. Through short period melt processing, 2212 phase decomposed into the 2201 and impurity phases, and then recovered by holding at 820 ℃ for 50h. The transverse cross ection of melt processed tape is shown in Fig.1. The visible grains have thicknesses of up 1μm and average lateral dimensions of approximately 20μm. A high degree of texture is obvious from Fig. 1, however many impurity phases mainly consisted of the 2 : 1 AEC (alkaline earth cuprates) phase are found inside oxide core. Some other compounds such as 14:24 AEC, CuO, 2201 and Ca_2PbO_4 phase were

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also detected, but in lower amounts.

Fig. 1 Transverse fracture section of composite tape after melt processing.

The texture of the 2212 phase had an important influence on that of the 2223 phase because the 2223 phase grew out of the 2212 phase[6]. After prolonged heat treatment at 835℃ for 200h, the oriented 2212 phase had completely transformed to the oriented 2223 phase during third heating cycle, that can be seen from Fig. 2 and Fig.3. Fig.2 shows the shapes of huge plate−like 2223 grains in fully−processed tape. The size of the 2223 grains increased fast with time and finally had average lateral dimensions of approximately 40μm, which were already much larger than that in normally processed tapes (generally grain size about 20 ~ 25μm) and seemed to improve the 2223 phase alignment with ab−plane parallel to the tape surface. A highly−aligned 2223 grains are obvious from Fig.3, even if almost all the grains are softly bent. The residual impurity phases, specially the 2 : 1 phase, still appear in the middle of the oxide core, though the amount of them has decreased.

Fig. 2 The shapes of huge plate−like 2223 grains in fully−processed tape

Fig. 3 SEM micrograph of a transverse fracture section of a Bi(2223) filament after the third heating cycle

In summary, the melt processing enhenced the grain alignment and connectivity by producing ample liquid phase. The short period of melt treatment and adequate liquid phase accelerated the growth of 2212 and 2223 grains, as well as the impurity phases. The impurities produced from the 2212 decomposition in melt processing can not convert to 2212 or 2223 completely during the later heat trement because of their relative hgih content and big size, and the residual impurities in oxide core would decrease the Jc value of Bi(2223) tape by blocking the critical current path within the tape.

A Jc of 10000A · cm^{-2} at 77K and 0T has been achieved in fully−processed tapes fabricated by this partial−melting process. The implication to achieve tapes with high Jc value is to make the samples melt in high Po_2 atmospheres to prevent excessive growth of 2 : 1 AEC phase. The further work is currently under study.

REFERENCES

1. J. B. Goodenough et al., J. Solid State Chem. **88** (1990) 115
2. B. Raveau et al., J. Solid State Chem. **88** (1990) 140
3. K. Sato et al., Appl. Phys. Lett. **57** (1990) 1928
4. S. X. Dou et al., Physica C **194** (1992) 343
5. S. X. Dou et al., Proc. Iss'92 (Kobe, Japan, 16−19 Nov. 1992)
6. Z. P. Xi et al., Supercond. Sci. Technol. 7 (1994) 908