Effects of Impure phases in Textured YBCO Superconductors
용융성장된 YBCO초전도체의 불순물상의 영향

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Abstract
The method for calculation of Y_2BaCuO_5 contents was set up. It was estimated that the optimum value of 211 contents in the textured YBCO superconductor as flux pinning center was about 20wt.%. Ag contents have no influence on the critical temperature,but have large influence on the critical current density of the textured YBCO. When Ag contents over 15wt.%, which was the solubility of condensed YBCO, the critical current densities tend to a stable value.
Keywords:Textured YBCO, Y_2BaCuO_5, Ag, Super--conductivities

1. Introduction

There are some extra non-superconductive $Y_2BaCuO(211)$ phase in the melted-condensed process due to the loss of the liquid phase($BaCuO_2$+CuO),which was caused by the slow cooling rate.Some works show that the 211 phase particles are effective flux pinning center in YBCO superconductor[1,2], and the critical current density (Jc) will increase with the increasing 211 phase content[3]. There are some opposite point of view which says that either Jc has no relation with 211 phase or Jc declined with increasing 211 phase contents[4,5].

The research for the effect of Ag doped in the sintering YBCO shows that the correct amount of Ag can eliminate the microcracks in the YBCO and improve the week link of grainboundries[6,7]. For the textured YBCO made by MTG, 10～15% Ag was added[8,9]. It was estimated that Jc increased with Ag contents in YBCO, but there was a maximum value of Ag contens over which Jc would decrease with increasing Ag contents[10]. In the paper, the authers measured the critical current densities of textured YBCO with diffrent 211 contents and different Ag contents, tested the regularity of the effects of 211 phase and Ag on the superconductivities.

2. Experament

2.1 Praperation of textured YBCO samples

The samples used in the experiment were all textured YBCO prepared by the Melted Textured Growth(MTG). The MTG process was carried out in the SiC furnace with 50mm constant temperature zone. The YBCO bar of $20\times7\times6mm^3$ was heated from room temperature to 1080℃ in 2 hours ar held at that for 1 hour, the temperature was reduced to 1020℃ in 30 minutes and was reduced again to 970℃ at the rate of 1~2℃/h, in the stage the melted YBCO was textured along the a-b plane of YBCO structure. After the condensation of YBCO melt, it was cooled to 400℃ to absorb oxygen.

2.2 Reference curve for determination of 211 phase contents in the textured YBCO

The six YBCO sintering samples with 5, 10, 15, 20, 30, 40wt.% of 211 phase contents were taken X-ray diffraction under the same test condition. <110> and <013> peaks of 123 phase, and <311> peak of 211 phase were selected to be characteristic peaks. The curve of $I_{211}/I_{211}+I_{123}$ versus 211 phase contents was drawn in Fig.1. The curve will be the reference for the calculation of 211 phase contents in textured YBCO.

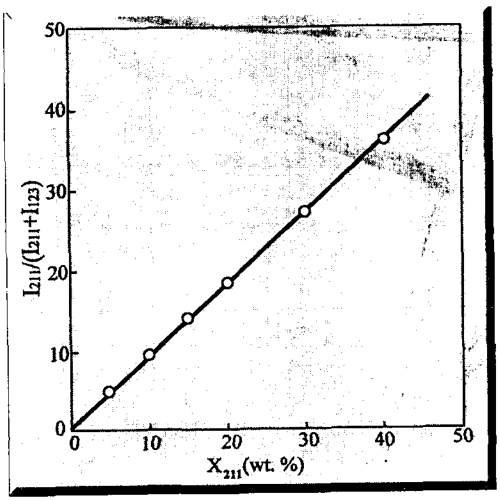

Fig.1 Relation of $I_{211}/I_{123}+I_{211}$ and 211 contents in YBa_2Cu_3O

2.3 Addition of Ag in YBCO

The black Ag_2O powder, produced from the decomposition of Ag_2CO_3, was mixed in YBCO powder before MTG process. It was proved that the melting points of Ag doped YBCO reduced with increasing Ag contents and the solubility of Ag in YBCO is about 15wt.%, which were important references of the MTG program designing for preparation of textured YBCO.

2.4 The measurement of superconductivitis(Tc,Jc)

The magnetic hysteresis was measured by a vibrating sample magnetometer at 77K and the critical current densities were calculated by means of Bean's model. The critical temperatures were determined by AC susceptibility. The dimension of Ag particles and their distribution in textured YBCO were observed by Scanning Electron Microscopy(SEM).

3.Results and Discussions

3.1 The optimum value of 211 phase contents in the textured YBCO

Samples with dimension of about $10\times5\times1mm^3$ cut from textured YBCO bars were heated at 450℃ for 50 hours under oxygen flow to absorb oxygen. After the heat treatment several 10 miligrams of YBCO powder were taken from each textured YBCO samples to do the X-ray diffraction and the 211 phase contents were calculated using the curve in Fig.1. The YBCO samples ($10\times5\times1mm^2$) were used to measure the critical current densities respectively. The 211 content and critical current density were correspondence with each other for the same sample. Their relation was shown in Fig.2. It can be seen that the optimum value of 211 contents in the textured YBCO is about 20wt.% and before this value, Jc increases

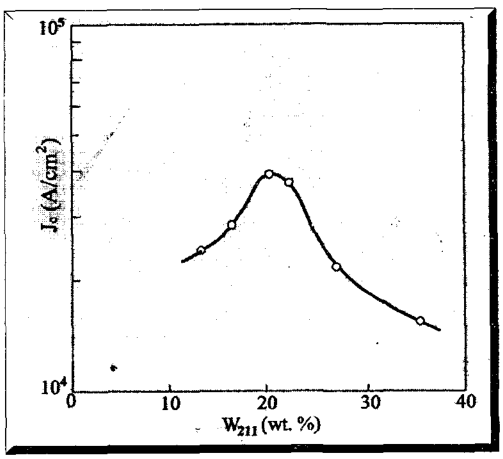

Fig.2 Relation of Jc(H=0.01T) and 211 phase contents

with increasing 211 contents, and after that value Jc decreases with increasing 211 contents. It seems that as the flux pinning centers, 211 particles could make critical current density increase with 211 contents, but as the nonsuperconductive phase 211 particles could make critical current density decrease when the volume ratio of 211 phase was too large.

3.2 Effect of Ag on the superconductivities of textured YBCO

The critical temperatures determined by AC susceptibility of textured YBCO samples with different Ag contents(0,4,8,12,16,18wt.%) were shown in Fig.3. The Ag contents did not influence on critical temperature of YBCO in the experiment, the same phenomenon was reported in reference[11] for the sintering YBCO sample.

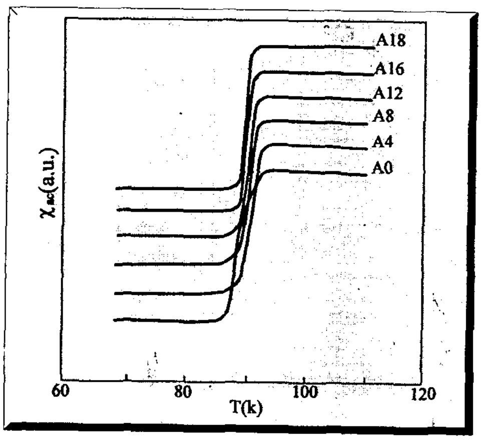

Fig.3 AC susceptibility of textured YBCO

Ag contents have large influence on the critical current density as shown in Fig.4, in which Jc increases with increasing Ag contents when Ag contents are less than 15wt.%, while Jc tends to a stable value,$(7\sim8)\times10^4$A/cm^2(0.01T,77K), when Ag contents are over 15wt.%, the solubility of Ag in condensed YBCO, the extra Ag will escape from the YBCO sample into slag on the substrate.

4. Conclusions

The optimum value of 211 contents of textured YBCO is about 20wt.%, before this value, Jc increases with increasing 211 contents, after that

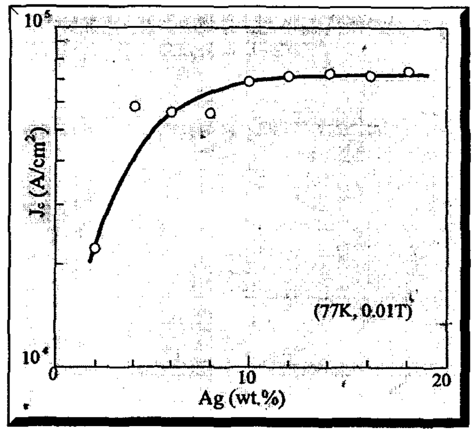

Fig.4 Relation of Jc and Ag contents with diffrent Ag contents of textured YBCO

point Jc decreases with increasing 211 contents. Ag contents has no influence on Tc of textured YBCO, but Jc will be influenced by Ag contents, Jc increases with increasing Ag contents in YBCO when Ag contents are less than 15wt.%, Jc will tend a stable value, $(7\sim8)\times10^4$A/cm^2(0.01T,77K) when Ag contents are over 15wt.%.

Acknowledgments

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