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Surface Protection of YBCO Superconductors
YBCO초전도체의 표면보호에관한연구

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Abstract

Ag coating on the textured YBCO and PTFE coating on the sintering YBCO were prepared. The critical current densities of different YBCO samples with and without coatings were compared. Both of Ag coating and PTFE coating can well protect YBCO from moisture and CO_2.

Key words:YBCO,Ag coating, PTFE coating, Moist test, Critical current density

1. Introduction

The YBCO superconductor can react with H_2O and CO_2 in air, which reduce the superconductivity and makes the YBCO material powdered[1,2]. The reactions are as followings

$$YBa_2Cu_3O_{6.5+\delta} + \frac{7}{2}H_2O = 2Ba(OH)_2 + Y(OH)_3 + 3CuO + \frac{\delta}{2}O_2$$

$$Ba(OH)_2 + CO_2 = BaCO_3 + H_2O$$

In the laboratory condition, especially in the humid summer the YBCO samples exposed in air will be damaged in several ten days. The above reactions expand from the surface into the inside of YBCO via grainboundaries. The corroded grains of a well oriented YBCO will obivously become convex on the surface of YBCO. The reactions occur in grainboundaries due to the larger chemical activity of the grainboundaries. After the reactions the oriented YBCO will cleave in the grainboundaries and become powdered. A typical sample was shown in Fig.1 in which the textured YBCO was placed in air for 50 days in the humid summer. After the heat treatment for oxygen absorption of YBCO at 450℃ in air, on the surface of YBCO there was a white powder film(see Fig.2). The X-ray diffraction pattern shows that the composition of the white powder is $BaCO_3$.

Fig.1 Corrosion of texured YBCO in the humid summer for 50 days

Fig.2 Corrosion on the surface of YBCO in heat treatment at 450℃ in air

In order to protect YBCO from the corrosion of humid air and CO_2, some authers have already coated protective film on the surface of YBCO materials[3,4]. In the paper silver coating on the texured YBCO and PTFE coating on the sintering YBCO were prepared and the protective examinations of the coatings was taken place in the hot humid air.

2. Experiment

2.1. YBCO samples for the protective tests

The samples coated polytetrafluoroethylene(PTFE) were the $YBa_2Cu_3O_x$ with dimension of $(15\sim20)\times5\times5mm^3$ which were cut from the sintering YBCO bulks. The samples coated Ag were the textured YBCO with dimension of $10\times5\times2mm^3$ which were cut from the YBCO bars made by MTG process described details in the previous work[5].

2.2.Proparation of Ag coating on the textured YBCO

The Ag_2O paste was brushed on the surface of textured YBCO homogeously, and it was dried at room temperature and then it was heated at 500℃ for 2 hours in a furnace. After the treatment Ag_2O was decomposed to metal Ag which was firmly contacted onto the surface of YBCO, the detail was shown in reference[6].

2.3.Proparation of PTFE coating on the sintering YBCO

On each sample four Ag wires were welded for the measurement of critical current density in advance because of insulation of the PTFE coating. Xylene solvent was mixed with PTFE and resin and stirred by a glass stick homogenously and let the bubbles escape completely. The solution was coated on the surface of YBCO, and then the samples were put in the baker heated at 100℃ for 10 minutes. In order to form a continuous PTFE film, the brush process could repeat several times.

2.4. Moist test of the coated YBCO

For the Ag coated YBCO, the samples were placed in top part of a glass container, the water at the bottom of the container was heated at 60℃, its humidity was 98%, the hot moist test was lasted for 24 hours. For the PTFE coated YBCO, the temperature of the moist test was 70℃, the samples included the Ag electrodes were suspended on the top part of the glass container. The values of Jc were measured in every certain amount of minutes.

3. Results and Discussions

3.1 Corrosive Products of YBCO in hot moisture

X-ray diffraction was taken for the YBCO sample after hot moist test above 70℃ water(shown in Fig.3). In order to compare the corrosion products the corrosion of YBCO powder in hot moisture was carried out and its X-ray diffraction pattern was shown in Fig.4. In both Figures the marks represent following compounds: ▽:Y-123, ⊙:CuO, ○:$BaCO_3$, *:$BaO\cdot8H_2O$ respectively.

After the hot moist test a film of white powder could be seen on the surface of YBCO plate, which was easy to take off. The composition of the white powder was $BaCO_3$ mainly and CuO.

3.2.Ag coating on textured YBCO superconductor

SEM observation showed that the Ag coating on

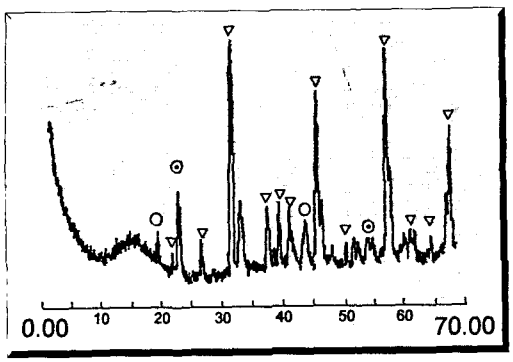

Fig.3 X-ray diffraction pattern of YBCO plate after hot moist test

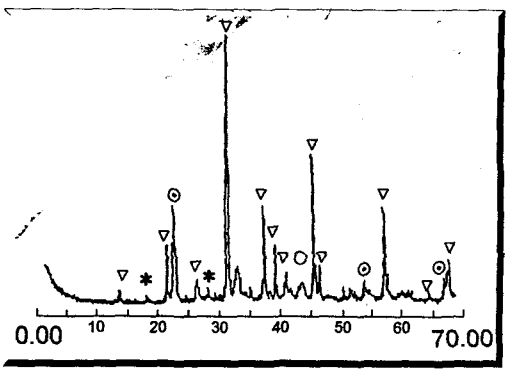

Fig.4 X-ray diffraction pattern of YBCO powder after hot moist test

the textured YBCO was formed from Ag flakes with side of $2\sim8\,\mu m$ and without pores. The boundary between Ag coating and YBCO are very smooth, the thickness of Ag coating is about $8\,\mu m$. The hysteresis loops of YBCO superconductors without Ag coating(A), with Ag coating(A1,B1), with Ag coating and after the hot moist test(A2,B2) were measured by a Vibrating Sample Magnetometer. From the hysteresis loops critical current densities could be calculated by Bean's model, $Jc=20\Delta Md^{-1}$. The results of the calculation were shown in Table 1. It is seen that Jc values of sample A, A1 and A2 are very close, that of samples B1 and B2 are almost same. It means that the Ag coatings have very well protective effect in moisture and CO_2, and Ag coating does not influence the oxygen absorption of YBCO.

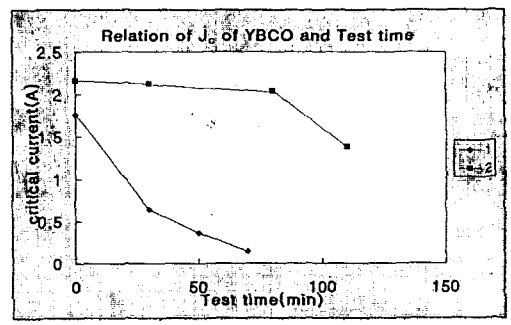

Fig.5 Jc changes of PTFE coated YBCO with the test time in hot moisture

4. Conclusions

The textured YBCO can be corroded in moist ambient. The corrosive products are $BaCO_3$ and CuO. Ag coating does not influece the oxygen absorption of the textured YBCO and its superconductivity, but has very well protective effect for the textured YBCO from moisture and CO_2. PTFE coating also has effective protection of YBCO from moisture and CO_2, but oxygen absorption of YBCO should be taken before the coating.

Acknowledgements;

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