

Production of high quality BSCCO superconductor

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ABSTRACT

The production of high quality BSCCO thin film is grown on MgO (100) substrate by using PLD technique. The surface appearance of the BSCCO thin film on the MgO substrate is observed with the help of SEM. The thin film is characterized with XRD method. Observe these results represent the good quality of Bi-2212 thin film, good electrical, epitaxial growth of film and the magnetic properties. The J_c is calculated in this process. This critical current density J_c is strongly dependent on the temperature and magnetic field. The Bi-2212 film current densities on MgO substrate at different substrate are measured. The current density will be calculated as $6.3 \times 10^6 \text{ A/cm}^2$.

1. Introduction

The BSCCO superconductor was discovered by Hiroshi Maeda and colleagues in Japan in 1988. The general chemical

formula is $\text{Bi}_2\text{Sr}_2\text{Ca}_{n-1}\text{Cu}_n\text{O}_{2n+4+x}$. The Bi-2212 having the transition temperature approximately 80 K respectively.

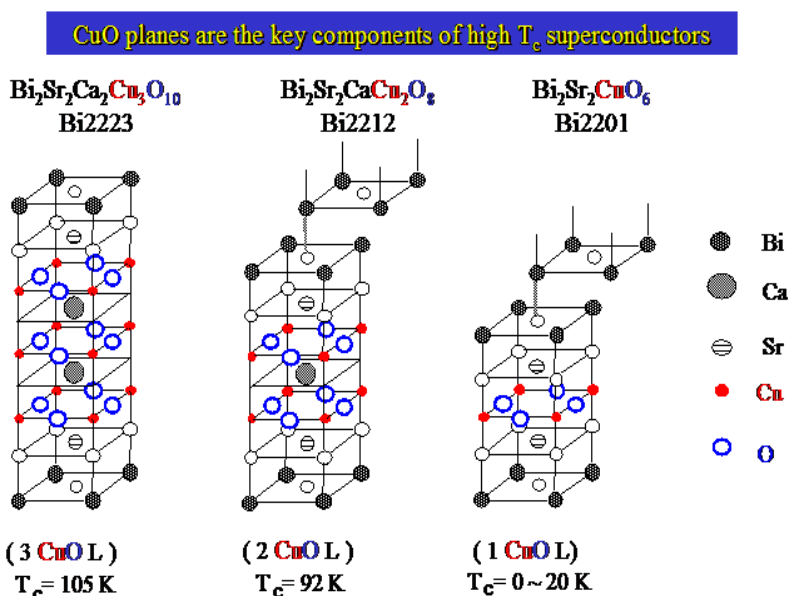


Figure 1. The crystallographic structure of BSCCO Superconductor

The Ca atom forms a layer within the interior of the CuO_2 in Bi-2212 and Bi-2223 and the Ca layer is not in the Bi-2201 phase. The Cu atoms form an octahedral coordination with the O_2 atoms in Bi-2201. The Cu atoms consist of two coordinations, one copper atom is bonded with four O_2 atoms and the remaining Cu atoms with five O_2 atoms in a pyramidal arrangement. If $n=1$ the compound $\text{Bi}_2\text{Sr}_2\text{CuO}_{6+x}$ becomes Bi-2201. If $n=2$ the compound $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+x}$ is Bi-2212, and $n=3$ the compound $\text{Bi}_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_{10+x}$ becomes Bi-2223. The $\text{Bi}_2\text{Sr}_2\text{Ca}_{n-1}\text{O}_x$ system is an HTSC compound used in the application of power transmission of cables to Josephson junction based electronic devices. The laser ablation or PLD is a useful technique for producing high quality barium strontium calcium copper oxide (BSCCO) superconducting thin film. Consider the results of the ablation process; we will explain the target stoichiometry in the ablated cloud. There are many techniques for Bi-2212 thin

films are performed by molecular beam epitaxy (MBE), liquid beam epitaxy (LBE) and pulsed laser deposition (PLD) technique. So in this process we can prepare BSCCO superconductor grown on MgO (100) substrate with the help of PLD method. The surface morphology of the BSCCO superconductor on MgO substrate can be explained with the help of SEM. The characteristics of BSCCO superconductor on MgO (100) substrate can be explained with the help of XRD pattern method.

2. Experimental process

The BSCCO HTSC for preparing purposes we can take precursor powder with Bi_2O_3 , SrCO_3 , CaCO_3 and CuO are prepared by solid state reaction. The powders are calcined in this experimental process for 24 hours in air at 830 °C. The calcined

powder is compressed in to 15mm diameter of disk and polyvinyl alcohol is the binder in this process. The powder disk is heat at 850 °C for 160 hours. The MgO substrate is solution take in ultrasonic cleaner and deionised with water, ethanol and acetone annealing at

800°C before deposition. The exciter laser wavelength 248nm and frequency 3hz is operated at 300mj per pulse for 30 minutes for each depositions. The substrate is mounted on the heater on the cross area of the flume and the ambient oxygen pressure (PO₂) is kept at 0.2mbar in this experiment process. The films are annealed at 680°C for 2hour and cool to room temperature for 3hours. The thin films T84, T92 and T93 are exist annealing at 845°C for 3hours, 2 hours and 1 hours and the film thickness is 272nm. The crystallographic texture of

the film is studied by using XRD. The J_C of the film calculate by using the relation

$$J_C = \frac{60a|\Delta m|}{b(3a-b)}$$

Where a and b are the length and width of the sample and m is the difference of the magnetization between the field up and down branches.

3. Experimental Results

The SEM is used to investigate the PO₂, energy of the laser pulse and the substrate temperature on the surface of the film. The SEM image of the film deposition on the substrate MgO (100) at 0.2mbar oxygen (O₂) E =300 mj per pulse and T_S is 730°C. The SEM images of the Bi-2212 film on the MgO (100) substrate is shown in figure (2).

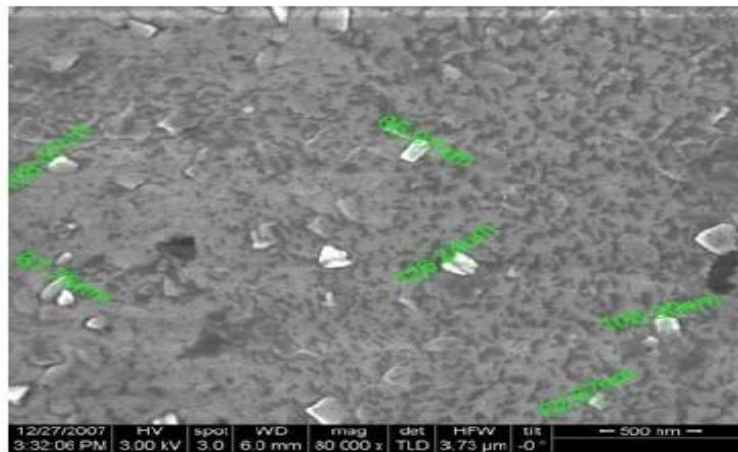


Figure 2. The SEM micrograph image of surface of BSCCO film on substrate MgO

The Bi-2212 thin film on MgO substrate, T93 annealing at 845°C for 1hour, T92 annealing at 845°C for 2hour and T84 annealing at 845°C for 3hours shown in the figure (3)

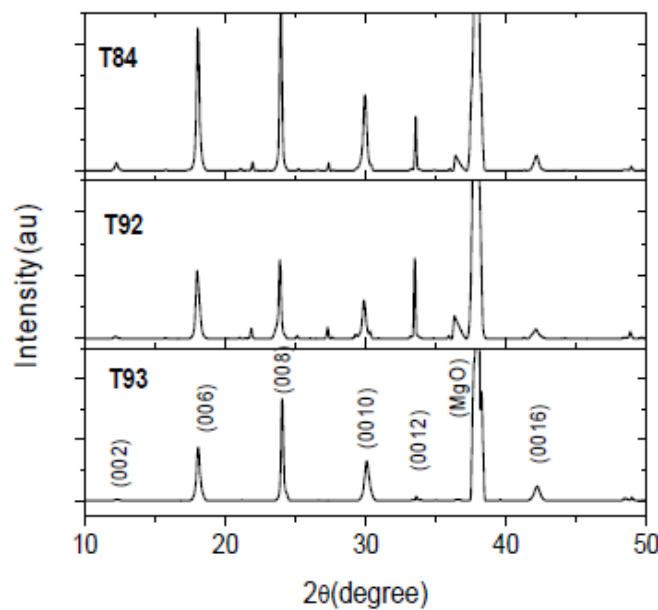


Figure 3. The XRD patterns of the Bi-2212 film.

The above figure shows the BSCCO film of the high quality has been epitaxial grown on crystalline MgO Substrate. The temperature and resistivity R(T) of Bi-2212 film on substrate

MgO is represents in the figure (4). The thin film is exhibit good superconductor properties when the T_{C- onset} = 95K, and T_{C - onset} =75K .

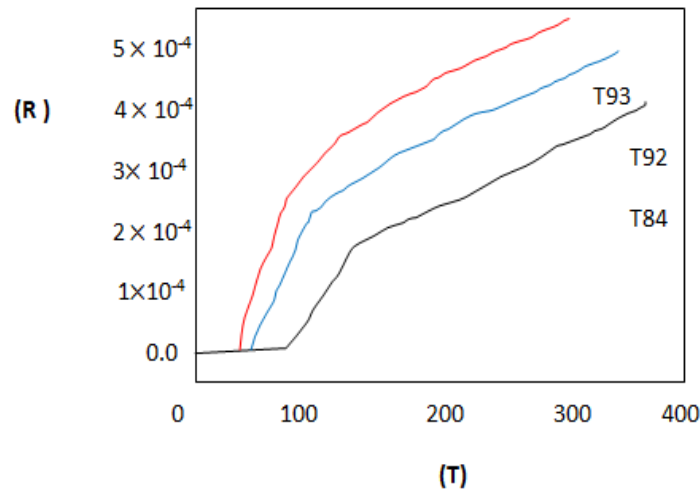


Figure 4. The resistivity and temperature of Bi-2212 film on MgO (100) Substrate.

We can find the value of T_c -onset increasing when time annealing increases in this process. Consider the length (a) of the film a is 2.8mm , the width (9) of the film is 2.5mm and the

thickness(d) of the film is 272nm and these values are substitute in the above equation we can calculate the J_c is $6.3 \times 10^6 \text{ A/cm}^2$.

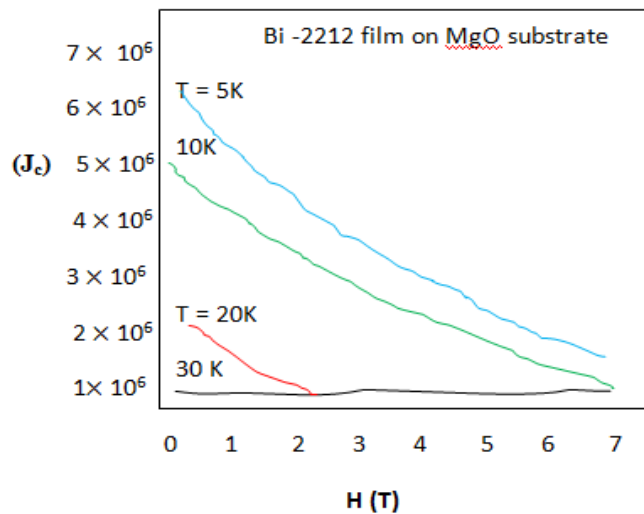


Figure 5. The J_c of Bi-2212 film on substrate MgO dependent on magnetic field at different temperatures $T = 5\text{K}$, $T = 10\text{K}$, $T = 20\text{K}$, and $T = 30\text{K}$.

The J_c values are initially increases with decreasing of the magnetic field .The J_c has the maximum value is $6 \times 10^6 \text{ A/cm}^2$ at 5K at the magnetic field is 0.5T. The J_c is maximum at 0.5T, when the superconductor is exhibit pinning force.

4. Conclusion

The production of Bi-2212 thin film is grown on MgO substrate by using PLD technique. Observe the experimental

results, the Bi-2212 film on MgO substrate by using SEM and characteristic of the film on MgO substrate with the help of XRD method. The results shows that the thin film is exhibit good superconducting properties when T_c -onset = 95K and T_c -zero = 75K. The J_c is calculated as finally $6.3 \times 10^6 \text{ A/cm}^2$ in this experimental process.

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