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Growth of (001) or (115) Bi-2201 Thin Films by Spin Coating and MOCVD Targeting Future Electronics Applications

K Endo[1], T Kaneko[1], T Moriguchi[1], H Takemata[1], T Takada[1], N Ikenaga[1], P Badica[2]

[1] Research Laboratory for Integrated Technological Systems, Kanazawa Institute of Technology (KIT), Yatsukaho, Ishikawa 924-0838, Japan

[2] National Institute of Materials Physics, Magurele, Atomistilor 105bis, 077125, Romania

E-mail: kendo@nepyune.kanazawa-it.ac.jp

Abstract. Thin films of $Bi_2Sr_2CuO_6$ (Bi-2201) with (001) or (115) orientation were grown on $SrTiO_3$ substrates. These films are expected to be useful as component films of heterostructures and devices (e.g. as insulators). We used two chemical routes, namely spin coating followed by thermal annealing and MOCVD. For both routes we demonstrated growth of c-axis and non-c axis thin films depending on the selected orientation of the $SrTiO_3$ substrate. To our knowledge, films of (115) Bi2201 obtained by spin coating or MOCVD are reported for the first time.

1. Introduction

In the last years, the interest in chemical routes for the growth of high temperature superconducting (HTS) films and the auxiliary films (used together with HTS ones in different applications) significantly increased. This is because films obtained by chemical routes are cheaper than those obtained by other methods. Much of the effort was devoted to development of films produced by chemical routes for coated conductors and only a few works are looking to potential of these films for electronics. In addition, $YBa_2Cu_3O_7$ (Y123) system was much investigated, while for other HTS systems a significantly less level of information is available.

2. Experimental

(001) and (110) $SrTiO_3$ substrates were used for the growth of (001) and (115) $Bi_2Sr_2CuO_6$ (Bi-2201) films, respectively. Substrates are from Furuuchi Chem. Co., LTD.

Coating solution is supplied by Kojundo Chem. Lab. Co., LTD. Spin coating was performed at 3000 rpm for 30 min., and it was followed by heat treatment at 820°C for 1 h for the (001)Bi2201 and at 710°C for 1 h for the (115)Bi2201 .

Metal-organic-chemical-vapor-deposition (MOCVD) was carried out with unique laboratory-designed machine of horizontal cold-wall type [1]. Raw materials were Metal- DPM (DPM is abbreviation for di-pivaloyl-methanate and Metal = Sr, Ca, Cu, Y, Ti) and $Bi(C_6H_5)_3$ (triphenyl-Bi). Growth temperature was 750°C for 1 h for both (001)Bi-2201 and (115)Bi-2201 films.

3. Result and Discussion

We present growth of (00l) and (115) (Bi-2201) thin films by spin coating. Orientation control is obtained by using substrates of (001) and (110) $SrTiO_3$, respectively. The principle based on lattice matching relationship between the substrate and the film is illustrated in Fig. 1. We also compare these films obtained by spin coating with (001) and (115) Bi-2201 films deposited on the same substrates by MOCVD.

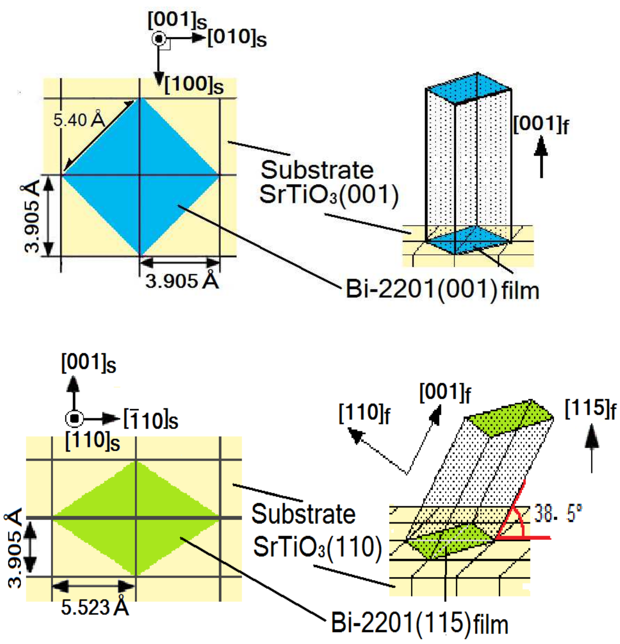

Fig. 1 Lattice matching relationship for the growth of (00l) and (115) Bi-2201 thin films.

X-ray diffraction patterns and SEM images for (00l) and (115) Bi-2201 thin films obtained by MOCVD are shown in Figs. 2, 3, while for films grown by spin coating are in Figs. 4, 5.

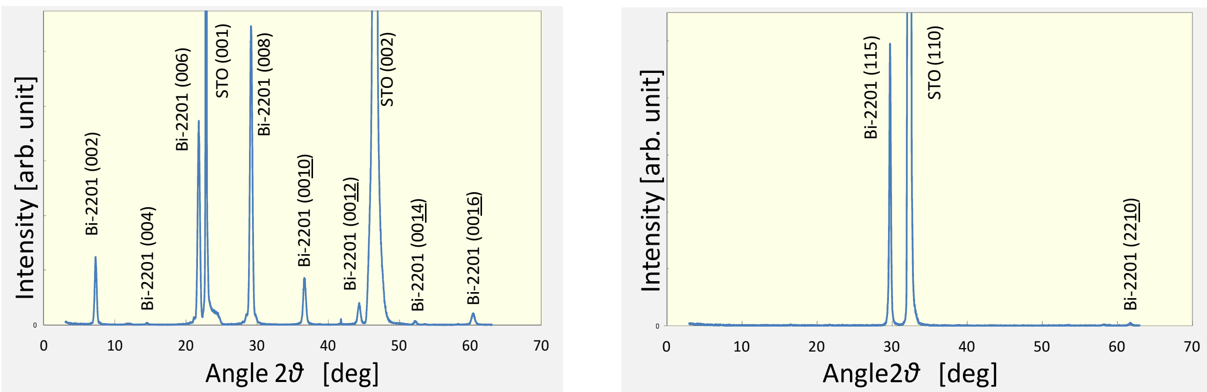

Fig. 2 XRD patterns of left - (001) and right - (115) Bi-2201grown by MOCVD.

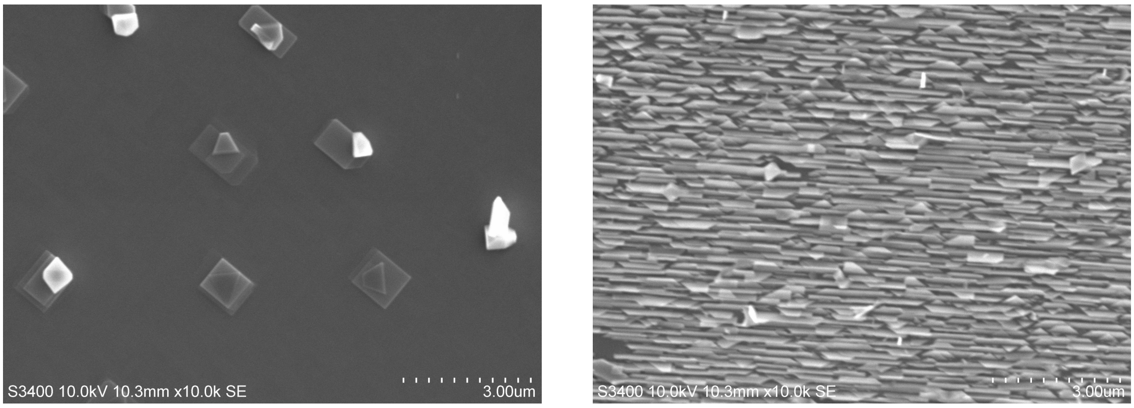

Fig. 3 SEM images of left - (001) and right - (115) Bi-2201grown by MOCVD.

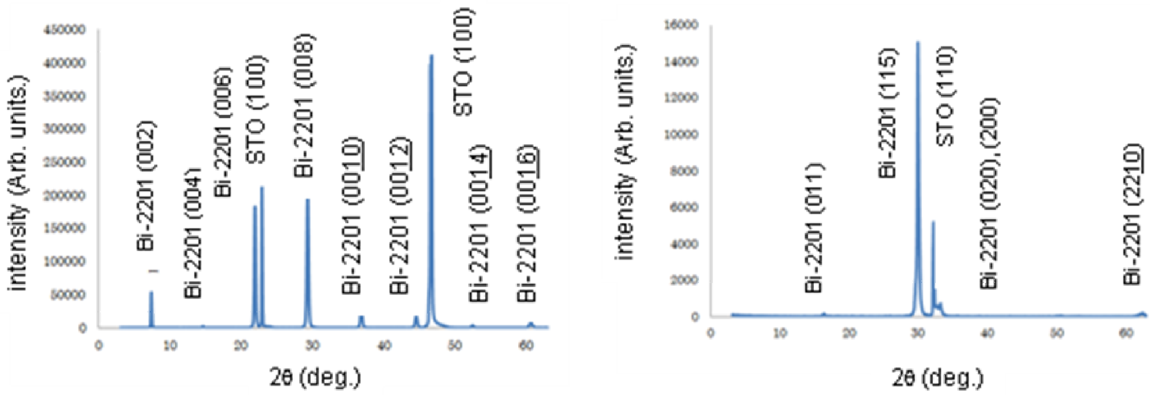

Fig. 4 XRD patterns of left - (001) and right - (115) Bi-2201grown by spin coating.

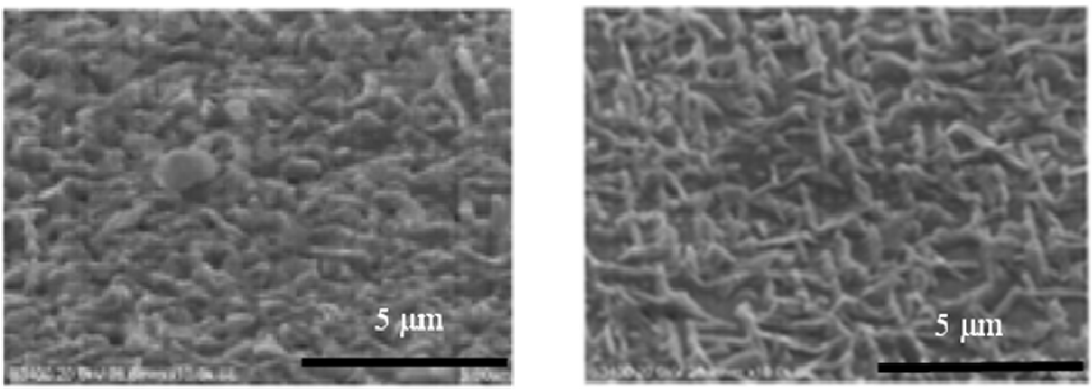

Fig. 5 SEM images of left - (001) and right - (115) Bi-2201grown by spin coating.

The first important observation is that our results demonstrate that orientation control is independent of growth method: for both growth techniques, i.e. MOCVD and spin coating, (001) and (115) orientations and single phase Bi-2201 films are obtained. However, there are also significant differences as follows:

(i) Films obtained by MOCVD have a higher morphological uniformity and a lower roughness (compare Figs. 3 and 5).

(ii) The (115) Bi-2201 grown by MOCVD shows a higher degree of *in-plane* alignment than for the film obtained by spin coating (compare Figs. 3 and 5).

(iii) The (115) Bi-2201 grown by MOCVD shows less residual impurity phases or orientations than for the film obtained by spin coating (compare Figs. 2 and 4).

All Bi-2201 films in this work were not superconducting and are thought as possible candidate insulating layers for design of certain stacked composite heterostructures.

4. Conclusion

Orientation control of Bi-2201 thin films through lattice matching between the film and the substrate was realized when growth of the films is done by spin coating and MOCVD. The quality of spin coated films is lower than for advanced deposition techniques such as MOCVD, but spin coating is a simple and cheap alternative.

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References

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