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Texture study of MTG produced YBaCuO ceramic using X-ray and neutron diffraction

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The X-ray and neutron diffraction pole figure technics were employed for studying the free surfaces and bulk textures of a MTG YBCO sample. We found a development and an enlargement of the texture from the free surfaces to the entire volume with {113}, {114} or {115} planes parallel to the surface. The 211 phase particulates are randomly oriented.

1. INTRODUCTION

It is now well known that weak links can be substantially eliminated in YBCO compounds by producing a high degree of texturing [1], which avoid high angle grain boundaries. Melt Texture Growth processing (MTG) [2] is one of the methods which offer the possibility of such texturation. The qualitative evaluation of the texture can be obtained by several methods such as magnetic measurements, Raman spectroscopy, rocking curves or simply θ-2θ scans. However, up to now, only pole figures obtained by diffraction methods are capable to quantitatively describe the distribution of the orientations.

Both neutron and X-ray diffraction measurements were used to characterize the texture of an $YBa_2Cu_3O_7$ sample grown by the MTG technique.

2. EXPERIMENTAL

The MTG processed sample was fabricated from the initial oxide powders [3]. A slow cooling rate of 1°C/h was used during the peritectic formation of the 123 phase. The re-oxigenation was done at ≈6°C/h. No thermal gradient was imposed nor detected inside the furnace. The resulting sample was a 42mm long bar of 10x5mm^2 rectangular section inside which a central part of 15mm was cut for X-ray analyses. In this later part two 5mm side cubes were cut for neutron experiments.

The X-ray pole figures were realized using the Schulz reflection geometry [4] and the copper $K_{\overline{\alpha}}$ radiation at 1.5418Å. At this wavelength the analysed depth is ≈10μm. The irradiated surface is of the order of several mm^2. We analysed the pole figures in the ranges $0 \leq \chi \leq 72°$ for tilt angle and $0 \leq \varphi \leq 360°$ for azimuthal angle, by steps of $\Delta\chi = \Delta\varphi = 0.9°$.

The neutron pole figures were carried out using the texture goniometer in transmission mode on the 6T1 line of Saclay source. The neutron wavelength was monochromatised at 1.158Å. The information is provided by the whole volume of the cube shape samples due to the high capability of penetration of neutrons. The angle ranges of pole figures were $0 \leq \chi' \leq 90°$ and $0 \leq \varphi' \leq 360°$ by steps of $\Delta\chi' = 2°$ and $\Delta\varphi' = 1°$ for the '123' phase, and $\Delta\chi' = \Delta\varphi' = 2.5°$ for the '211' phase.

The samples were positionned on the two goniometer in order to get parallel neutron and X-ray incident planes, χ and χ' rotation axes. However the φ and φ' axes are opposite rotations.

3. RESULTS AND DISCUSSION

Transport measurement on the initial bar indicated Jc=3900A/mm^2 before the contacts were broken.

The basis and application of pole figure method to the YBCO system has been detailed elsewere [5].

The X-ray texture analysis has been realized on two perpendicular faces. The pole figures are consistent with a bulk texture because of the orientation correspondances of several analysed directions between the two faces. Only one domain is observed on these figures. On each face no deviation of these orientations were observed on the scale of 15mm. Figure 1 shows the X-ray

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{103/006/113}$_{123}$ multipole figure of a free surface. The regular shape poles are dispersed by less than 5° at 15% of the maximal intensity, as a sign of a very strong texture.

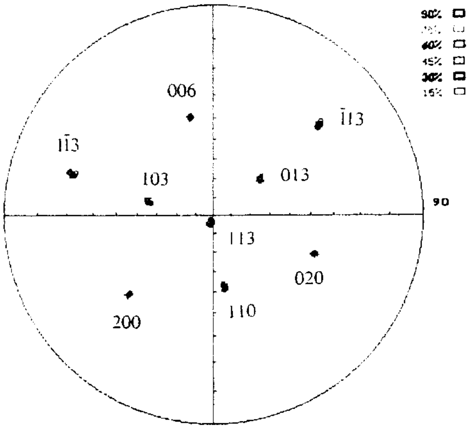

Figure 1 : X-ray {103/006/113}$_{123}$ multipole figure of a free surface.

Figure 2 represents the {114/105}$_{123}$ multipole figure collected at 6T1. The poles clearly show that it exists two domains inside the sample volume. These domains are extended at least on 10mm (two cubic shape samples were analysed) without deviation and are misoriented from one to the other by 5 to 10°. The mosaic of each domain is more extended in one direcion than in a perpendicular one, with more than two times the observed dispersion in X-ray experiments for the greater dimension.

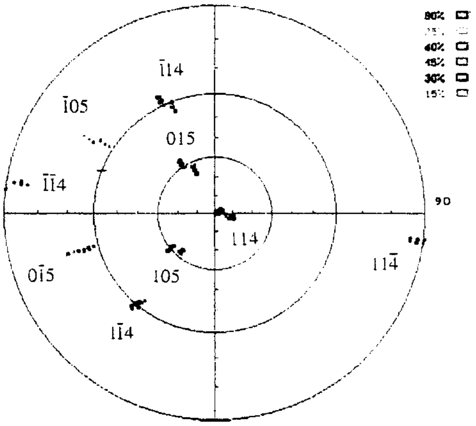

Figure 2 : neutron {114/105}$_{123}$ multipole figure of the entire volume of a cubic shape sample part.

This is the sign that in this case the texture developped from the largest free surface to the bulk of the ceramic.

On the other hand the {114}$_{123}$ poles reveal that in this case the texture nucleation begins with the {114} cristallographic planes parallel to the free surfaces. {113} or {115} planes (not shown here) should also verify this orientation in front of uncertainties of sample cutting and positioning.

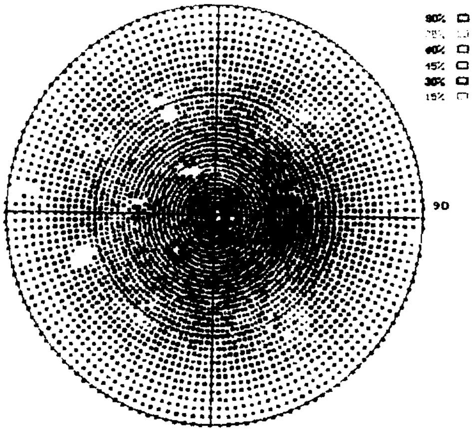

Figure 3 : neutron {421}$_{211}$ pole figure of sample of Figure 2. The {105}$_{123}$ as been removed.

We analysed also the texture of the minor 211 phase. For this phase the {421} reflection is the most intense with the use of neutrons. Unfortunately this reflection is overlapped with the {114/105/015}$_{123}$ one. As these later are very localised (and as the crystalline systems are different) it is possible to remove them from the {421}$_{211}$ pole figure. The uniform intensity then proved the random distribution of the 211 crystallites. This character can be seen from the point of view that no matching exists between 211 and 123, resulting in highly deformed region near the interfaces. This may have an importance on the pinning effect due to these particles.

4. REFERENCES

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