CONTROL OF IN PLANE ROTATION OF $YBa_2Cu_3O_{7-\delta}/CeO_2/SrTiO_3$ BIEPITAXIAL THIN FILMS. Henrik Pettersson[1], Karin Cedergren[2], Floriana Lombardi[2] and Eva Olsson[1], [1]Microscopy and microanalysis, Applied Physics, Chalmers University of Technology, SE-41296 Göteborg, Sweden, [2]Quantum Device Physics Laboratory, Microelectronics and nanotechnology, Chalmers University of Technology, SE-41296 Göteborg, Sweden, Email: henrik.pettersson@fy.chalmers.se

It is well known that the microstructure determines the transport properties of grain boundaries in high-temperature superconductors [1]. Here, artificial grain boundaries (AGB) of (103)/(001) $YBa_2Cu_3O_{7-\delta}$ (YBCO) films produced by pulsed laser deposition (PLD) have been investigated. The AGBs have been produced in such way that a tree-like structure with different interfacial orientations of the AGBs (θ = 0°, 5°, 10°,…, 90°) have been obtained on the same chip (shown in Figure 1).

The (103)/(001) YBCO biepitaxial AGBs were deposited on (110) $SrTiO_3$ (STO) substrates with a vicinal cut ($K\alpha$(010), α = 3.5 – 5.0°), with a patterned (110) CeO_2 seed-layer. The CeO_2 layer was patterned, in order to obtain the desired AGB interfacial misorientation angles. The YBCO grows in the (103) orientation on the (110) STO and with the (001) orientation on the CeO_2 seed-layer (shown in Figure 2).

Because of the epitaxial orientation relationship between the (001) YBCO and the CeO_2, there are two possible alignments of the YBCO a-b planes, namely parallel to the in plane directions of the substrate or rotated by 45º. We have found that either of the two different orientations can be selected by changing the deposition conditions of the CeO_2. High ablation frequency for the CeO_2 film (10Hz) results in non-rotated YBCO films and low frequency (1Hz) gives rise to rotated films.

In order to develop a further understanding of the growth mechanism of the film, YBCO/CeO_2 bilayers have been characterized by scanning electron microscopy (SEM) and transmission electron microscopy (TEM) cross-section. The film surface morphology has been studied using a Leo Ultra 55 field emission gun (FEG) SEM. The fine scale microstructure has been investigated by using a Philips CM 200 FEG TEM operated at 200kV equipped with a Gatan Imaging Filter.

The SEM investigations showed that the surface morphology was different between the rotated and non-rotated (001) YBCO films. The non-rotated film had a rough surface with facets. The rotated film was instead much smoother (which is shown in Figure 3). The difference in orientation was confirmed by selected area diffraction (SAD) in the TEM. Steps in the YBCO/CeO_2 interface in the rotated film (shown in Figure 4) were also observed.

[1] F M Granozio *et al*, *"Structure and properties of a class of CeO_2-based biepitaxial $YBa_2Cu_3O_{7-\delta}$ Josephson Junctions"*, Physical Review B 67 184506 (2003)

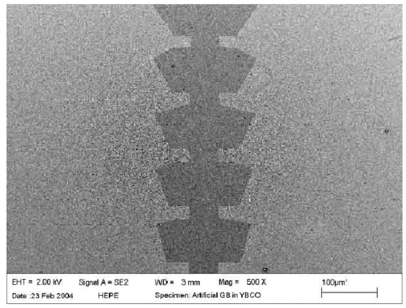

Figure 1. SEM micrograph of a part of (001) YBCO on top of patterned CeO_2 seed-layer.

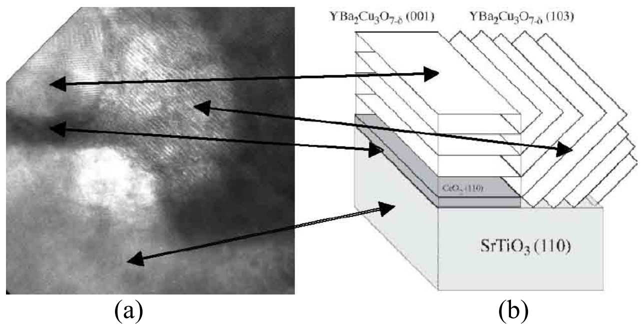

Figure 2. (a) TEM cross-section micrograph of a pure tilt grain boundary, where the different layers are seen. (b) Schematic of the boundary.

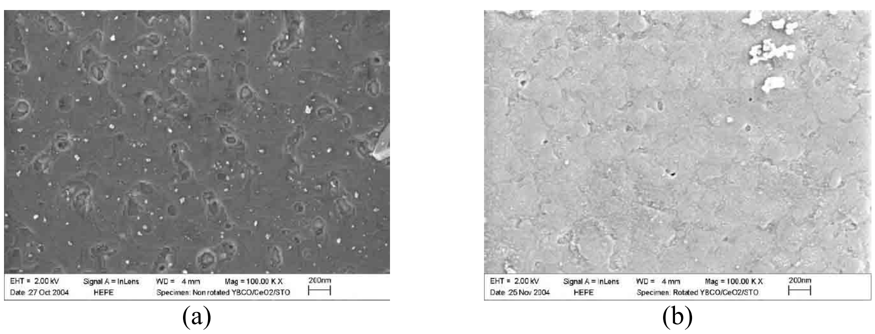

Figure 3. SEM micrographs of the two different rotated YBCO films. (a) Non-rotated film that has a faceted and rough surface. (b) Rotated film with a relatively smooth surface.

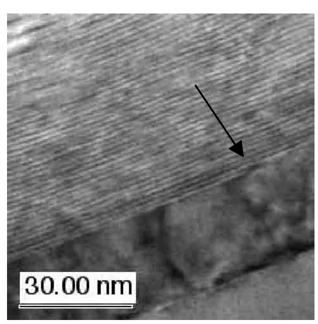

Figure 4. TEM micrograph of a (arrowed) rotated $YBCO/CeO_2/STO$ film, where steps of the $YBCO/CeO_2$ can be seen.