ESRF	**Experiment title:** Structural ordering and interface morphology in $[CaCuO_2]_n/[BaCuO_x]_2$ artificial superconducting superlattices.	**Experiment number**: SI627
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Report:

Thin film growth on vicinal substrates is a common technique to control or improve the interface and surface properties. Vicinal substrates were in fact systematically employed to study the growth process of high temperature superconducting materials and to control the defects structure, thereby influencing the transport properties in those compounds. Moreover, even substrate surfaces, which a re nominally exactly oriented, may have some miscut angle, which can influence the structure and the defect ordering in the film, leading to anisotropic properties even for an otherwise isotropic material. We already observed this effect in superconducting $[BaCuO_{2+x}]_2/[CaCuO_2]_3$ superlattices grown on (nominally well oriented) (001) $SrTiO_3$ (STO) substrates[1].

During this experiment we used X-ray diffraction and diffuse scattering measurements to study the effect of the substrate miscut angle on the structure of the $[BaCuO_{2+x}]_2/[CaCuO_2]_3$ superlattices grown on specially prepared STO (001) substrates with different miscut angles.

The samples were mounted in air on the 2+2 diffractometer of ID32 beamline in vertical configuration and the energy was selected at 18 keV. After alignment of the sample surface during the experiment the orientation matrix was defined with respect to the lattice parameters of the substrate ($a = b = c = 3.905$Å).

In order to investigate the periodicity and structural features of the sup erlattices in the z-direction, i.e., normal to surface, reciprocal space mapping in *symmetrical* configuration was performed in two orthogonal azimuthal directions. Furthermore, the *diffuse scattering* was measured by longitudinal and transverse scans to obtain, respectively, the in-plane and out-of-plane correlation properties. Diffuse scattering measurements showed subsidiary maxima (see fig.1) due to the presence of different morphologies at the interfaces with increasing the miscut angle, starting from ripple structure and going towards fractal structures when the miscut is about 1°.

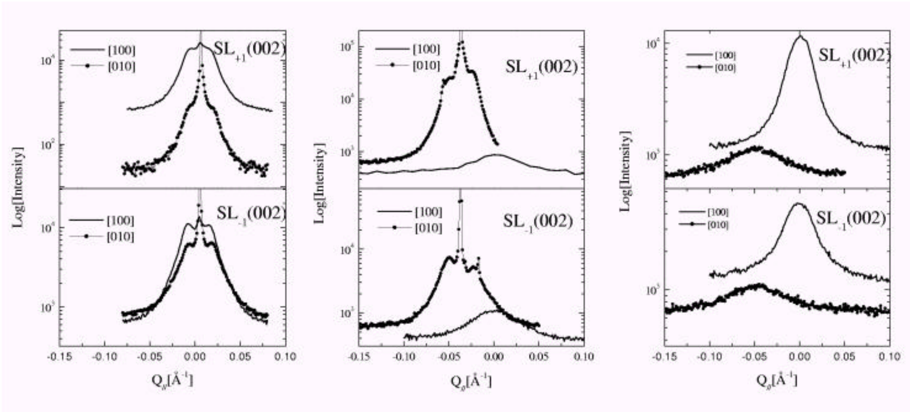

Fig.1 Diffuse scattering measured by longitudinal scans for three samples grown on STO with different miscut angles increasing from left to right.

Reciprocal-space mapping in *grazing incidence* configuration was then performed, to study the influence of the vicinality of the substrate on the strain relief process of our superlattices. Those measurements showed that increasing the miscut the crystal structure changes from pseudo-tetragonal to orthorhombic one with the presence of different domains in the case of intermediate miscut (see fig.2).

A two-dimensional layer-by-layer growth process prevails for thin layers of the superlattices on well oriented surfaces.

A publication of these results is being prepared.

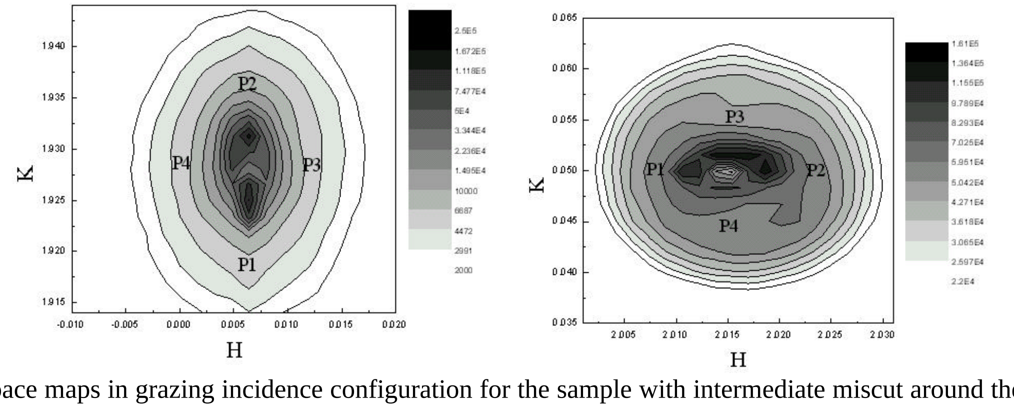

Fig.2 Reciprocal space maps in grazing incidence configuration for the sample with intermediate miscut around the (022) reflection (on the right) and the (202) reflection (on the left). The presence of 4 peaks is due to different domains: orthorhombic with twinning (P1 and P2) and tetragonal with a slight rotation of the in-plane crystallographic cell (P3 and P4).

References:

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[1] C. Aruta, J. Zegenhagen, B. Cowie, G. Balestrino, G. Pasquini, P.G. Medaglia, F. Ricci, D. Luebbert, T. Baumbach, E. Riedo, L. Ortega, R. Kremer, J. Albrecht, Phys. Stat. Sol. (a) **183**, 353 (2001).