ESRF

Experiment title:

X-ray standing waves in epitaxial $SmBa_2Cu_3O_{7-\delta}$

Experiment number:

S1-150

Beamline:

ID32 BL13

Date of Experiment:

from: 22.4.96 to: 27.4.96

Date of Report:

17.6.96

Received at ESRF
20 JUN 1996

Shifts:

12

Local contact(s):

Fabio Comin

Names and affiliations of applicants (*indicates experimentalists):

Alexander Kazim"rov[1], Tristan Haage[1], Luc Ortega[2], Andreas Stierle[2], Fabio Comin[2], Jorg Zegenhagen[1]

[1] Max-Planck-Institut f. Festkörperforschung, D-70569 Stuttgart, Germany

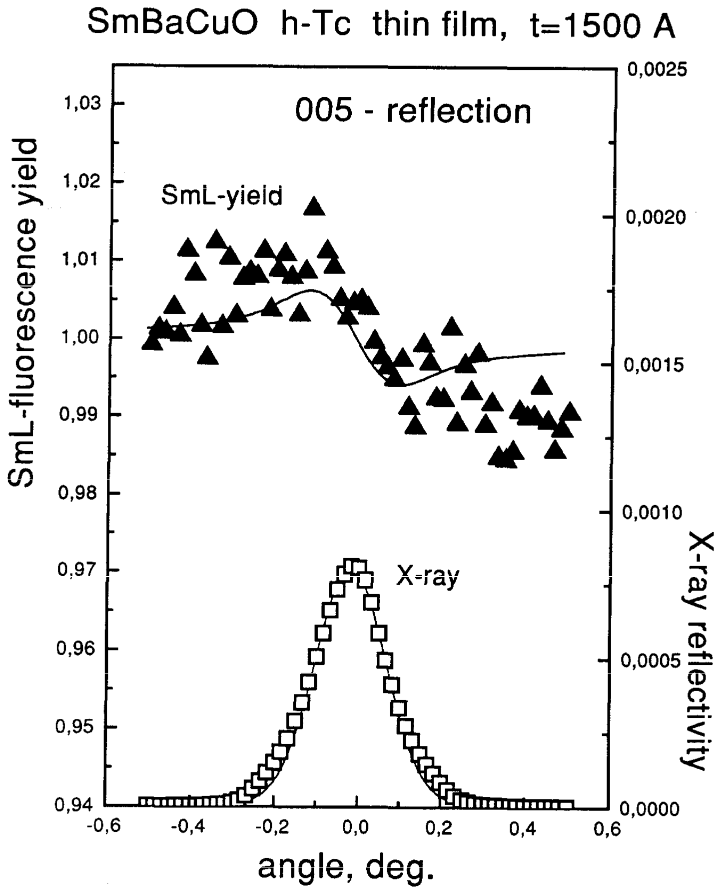
[2] ESRF

Report:

The x-ray standing wave (XSW) technique is an interferometric scattering technique which allows to determine amplitude F^Q and phase P^Q of the Qth Fourier coefficients of atomic distribution functions. An interference field with the spacing $d_I = \vec{H}^{-1}$ is typically created by Bragg reflection from as single crystal where the reciprocal lattice vector $\vec{Q} = 2\pi\vec{H}$ is defined by the Laue equation $K_H = K_0 + Q$. The XSW measurement is performed by scanning the single crystal reflection curve in angle and simultaneously monitoring the scattered yield the Y (photoemission , fluorescence or Auger electrons) from the atomic species understudy. This yield can be described by the function

$$Y = 1 + R + 2\sqrt{R}F^Q\cos(v - 2\pi P^Q) ,$$

where R is the reflectivity and v the phase between the incident and reflected x-ray wave which changes by $\Delta v = \pi$ while passing the reflection curve. The XSW method can only successfully be applied if R and v are well defined functions of the glancing angle Θ which means that they can be calculated for a given Θ by the so-called dynamical theory of x-ray diffraction. This in turn requires (Bragg reflecting) single crystals of comparably high crystalline quality. For many materials the required perfection may never be achieved for bulk crystals which means that the rather powerful XSW method could never be applied for structural investigations.



We show here a way to circumvent this problem by creating a x-ray standing wave in a thin epitaxial film. This has two advantages: (a) Many thin films can be grown with an excellent crystalline quality, hard to achieve for bulk materials and (b) the angular width $\Delta\Theta$ of the reflectivity curve is strongly enhanced since $\Delta\Theta$ is roughly inversely proportional to the number of reflecting tryst al planes. In Fig. 1 we show the result of an of a S W measurement, employing a (005) reflection in a 150 nm thick film of $SmBa_2Cu_3O_{7-\delta}$ on $SrTi0_3$(OOl). Shown is the reflectivity and the Sm L-fluorescence as a function of angle. The excitation energy was 7.7 keV. The symbols are the experiment al data and the solid lines are calculated curves. The curve for the fluorescence yield was calculated *with no* adjustable parameters for the known position of the Sm atoms in the orthorhombic unit cell of the $SmBa_2Cu_3O_{7-\delta}$ 90 K superconductor.