X-ray Diffraction on Brominated YBCO Single Crystals

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Beamline(s) **X22A**

Introduction: Bromination of underdoped insulating YBCO has been known to result in the recovery of superconductivity for some time [1]. However, the origin of the recovery is still not well understood although recent experiments suggest a connection with the formation of nanocrystalline BaBr2 [2]. We have performed the first systematic study of the changes in the (00l) reflections in brominates YBCO single crystals. Evidence is found for the formation of a thin layer of brominates YBCO at the surface of the film with a contracted c-axis lattice parameter- consistent with oxygenation.

Methods and Materials: The experiment was performed at beamline X22A at the NSLS. The incident photon energy was 10 keV. Using a Si(111) analyzer the longitudinal resolution at the (006) reflection of YBCO was determined to 0.0031 1/Å (HWHM) at our sample. Pair of single crystals from the same batch were used in these experiments. One of the samples was brominated by exposing it to Br2 vapor in a nitrogen atmosphere at 260ºC for 1 hr in a tube furnace.

Results: For the pure YBCO sample we find a lattice constant of c=11.81Å and a width of the rocking curve of about 0.15 degree (FWHM) at the (006) reflection. The Bragg reflections of (0 0 l)-type of the brominated sample are split into two peaks, as shown in figure 1, with corresponding lattice constants of 11.68 A and 11.72 Å respectively. The relative intensities of the split peak show an increase of the peak at smaller q with increasing l-values, whereas the intensity of the peak at higher q decreases with increasing l (see figure). This observation indicates that the origin of the peak with higher q is closer to the surface of the sample. The width of a rocking scan at the (006) reflection of around 0.5 degree (FWHM), slightly depending on the position of the sample in the beam, are significantly broader compared to the pure sample. It is particularly interesting that the rocking width of the peak with the higher q is significantly broader than the rocking width of the low-q peak. Further studies are required to determine the origin of the compression of the c-axis of the brominated sample.

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References: [1] Yu A. Ossipyan et al., Physica C 162-164, 79 (1989).
[2] D. M. Potrepka et al., Phys. Rev. B 60, 10489 (1999).

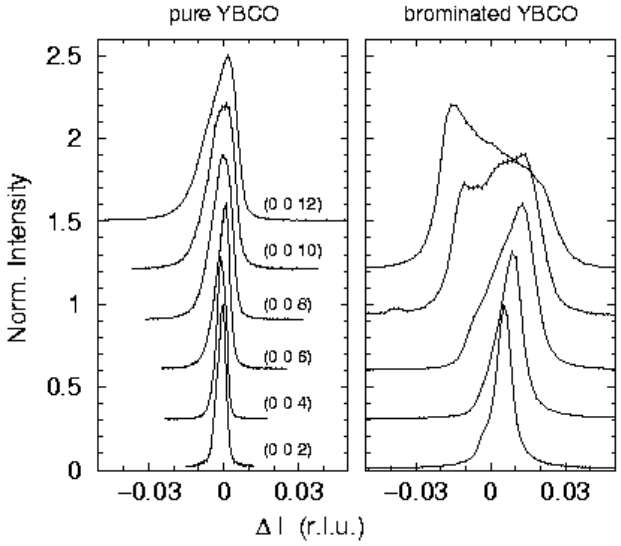

Figure 1. Series of (0 0 l)-scans on the pure sample (left) and on the brominated sample (right). For comparison the scans are shifted to the origin of the l-axis. The intensities are normalized to one in the maximum and each scan is offset by 0.15 units.