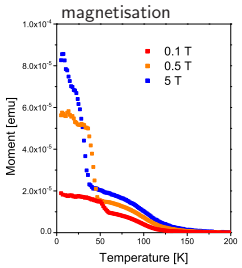
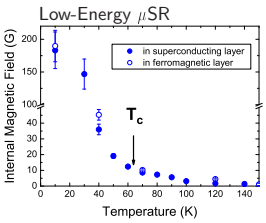
Jochen Stahn, Christof Niedermayer
Laboratorium für Neutronenstreuung, ETH Zürich & Paul Scherrer Institut

Magnetic Flux Distribution in High T_c SC / FM Multilayers

Motivation

Low-Energy μSR, magnetisation and ellypsometry measurements on multilayers of high T_c superconducters and ferromagnets showed an unexpected magnetic behaviour below T_c [1,2]:





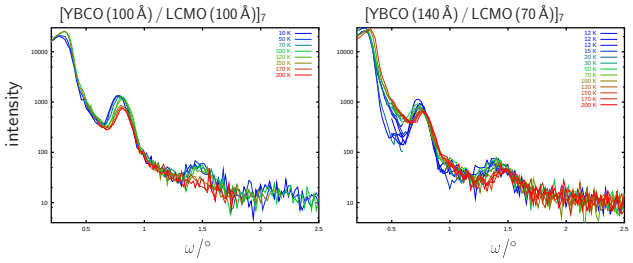
The depth-resolution of these methods (if any) is not sufficient to allocate the increased magnetic flux to certain regions.

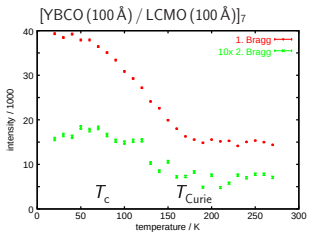
Neutron Reflectometry

Unpolarised neutron-reflectometry was applied to 2 samples with varying temperature and magnetic field strength H.

Instrument: TOPSI (Morpheus) with $\lambda = 4.74\,\text{Å}$

Specular n-reflectivity for various T at $H = 100\,\text{Oe}$.

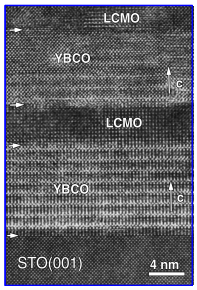




Integrated intensities of the 1st and 2nd Bragg peak of the sample with layer-thickness ratio 1:1.

Samples

The samples are multilayers consisting of the high T_c superconductor $YBa_2Cu_3O_{6.93}$ (YBCO) and the GMR ferromagnet $La_{1/3}Ca_{2/3}MnO_3$ (LCMO) on $SrTiO_3$.
The samples were grown by LASER ablation by H.-U. Habermeier at the MPI Stuttgart.



TEM picture of a YBCO / LCMO multilayer

Interpretation

increase of the 1st Bragg peak:

→ increased contrast between YBCO and LCMO due to the magnetisation of LCMO below T_{Curie}

appearance of the 2nd Bragg peak:
(which is symmetry forbidden for a thickness ratio 1:1)

→ the magnetic field profile does no longer match the chemical composition

? penetration of **B** some 10 Å into YBCO

decay of the intensity for $T < 20\,\text{K}$ for $[\text{YBCO}\,(140\,\text{Å})\,/\,\text{LCMO}\,(70\,\text{Å})]_7$:

? a "magnetic roughness" of the order of 50 Å appears

To clarify the open points and to reconstruct the profile B_z more measurements are necessary with

→ better peak-to-background ratio (ADAM@ILL),

→ measurements close to the critical angle (AMOR),

→ polarised neutrons.

References, Acknowledgements

[1] C. Bernhard *et al.*, PSI Scientific Report 2002 III, 84
[2] H-U. Habermeier *et al.*, Physica C **364-365**, 298 (2001)

We want to thank the people, who helped with theses experiments: J. Hoppler, J. Chakhalian, C. Bernhard, T. Gutberlet, M. Gupta

contact: jochen.stahn@psi.ch, URL: Morpheus.web.psi.ch