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ANTIFERROMAGNETISM IN $YBa_2Cu_3O_{6+x}$ NANOPARTICLES STUDIED BY ELASTIC NEUTRON SCATTERING

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The interplay between antiferromagnetism and superconductivity in the compound $YBa_2Cu_3O_{6+x}$ in bulk form has been intensively studied; see for instance.[1] We have initiated a similar study but now focusing on the properties as the size of $YBa_2Cu_3O_{6+x}$ nanoparticles becomes comparable to the coherence length for superconductivity. Here we present the first results on the antiferromagnetic phase of $YBa_2Cu_3O_{6+x}$ (x = 0.15, x = 0.25 and x = 0.37) nanoparticles, i.e. the behaviour of the Neél temperature for the various degrees of oxygen doping, studied by elastic neutron scattering.

The YBCO nanoparticles were prepared by a citrate gel modification of the sol-gel technique as described in[2], and subsequently reduced in a N_2 atmosphere to zero oxygen doping. The YBCO nanoparticle powder were in a controlled manner oxidized in an O_2 atmosphere obtaining different degrees of oxygen doping, i.e. x = 0.15, x = 0.25 and x = 0.37. The composition, crystal structure and the nanoparticle size and shape was characterized by x-ray powder diffraction and high resolution electron microscopy showing that the main part of the nanoparticles are pure tetragonal phase $YBa_2Cu_3O_{6+x}$, however a few percent of the impurity phase $Y_2Cu_2O_5$ is present. The YBCO nanoparticles are disk-shaped with the Cu-O planes perpendicular to the short axis of the disk and have an average diameter of 50 nm.

The elastic neutron scattering was performed at the triple-axis spectrometer RITA-2 at SINQ, Paul Scherrer Institute, Switzerland. The spectrometer was run at 5meV, and the beam was defined by slits at the monochromator, at the sample and at the analyser. A Be-filter with radial collimators was inserted between sample and analyser to reduce higher order scattering. Elastic q-scans were measured on the samples in the temperature range 15 K to 500 K. In the q-range we have studied there are two antiferromagnetic reflections, i.e. (½ ½ 1) and (½ ½ 2), but due to the very low intensity we have focussed our study on the (½ ½ 1) reflection. We have measured the behaviour of this reflection with temperature for x = 0.15, x = 0.25 and x = 0.37 and hereby measured the transition between the paramagnetic and antiferromagnetic phase and obtained the Neél temperature, which decreases with increasing x-value. For this nanoparticle size the Neél temperatures correspond to the bulk values.

REFERENCES

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