Critical behavior of ferromagnetic $La_{0.7}Sr_{0.3}CoO_3$ thin films

Abstract

The present thesis concentrates on the critical behavior of ferromagnetic $La_{0.7}Sr_{0.3}CoO_3$ thin films (LSCO) close to the magnetic phase transition.

The LSCO thin films were prepared by pulsed laser deposition and optimized with respect to their structural and magnetic properties.

For the characterization of the structural and magnetic characteristics various methods were used. By means of x-ray diffraction and electron microscopy the crystallinity and microstructure of the epitaxial films were examined, respectively. The analysis of the chemical composition was accomplished by Rutherford backscattering and energy dispersive x-ray diffraction (EDX).

Parallel to the investigations of the LSCO films a low-temperature measuring system for electrical measurements in magnetic fields up to 8 T in a temperature range from 1.5 K to 300 K was developed and built up including the necessary control and measuring software.

The central point of this work was dedicated to the characterization of the magnetic characteristics of the LSCO films. In comparison, single crystals and polycrystalline bulk samples were also available. At these samples temperature-dependent and isothermal magnetization measurements were accomplished by a SQUID magnetometer.

To determine the critical behavior of the samples the critical exponents of the susceptibility and the spontaneous magnetization in the proximity of the ferromagnetic phase transition were determined. For the exact determination of the critical exponents from the experimental data an evaluation routine in Matlab on basis of the Arrott representation method was used. In addition to the investigations of the critical behavior, electrical transportation measurements and neutron reflection measurements with spin-polarized neutrons were performed.

The investigations of this work show that, in contrast to the critical behavior of single-crystal LSCO volume samples where a three-dimensional Heisenberg behavior could be observed, the critical behavior of the thin films can be best described by a Mean-Field behavior. This behavior of the thin LSCO films can be essentially attributed to the "Finite-Size" effect. This is also confirmed by the fact that for very thick films ($d \geq 400$ nm) a trend to the three-dimensional Heisenberg behavior can be recognized.