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Report:

Conventional transparent conducting materials (TCMs) like Indium tin oxide (ITO) are transparent wide-gap semiconductors in which an enhanced electric conductivity is achieved via doping. Correlated metals have recently been identified as a promising alternative for utilization as TCMs. Correlated metals possess an intrinsic high conductivity and their transparency in the optical spectral range can be increased by tuning electron-electron interactions.

In this study, phase-pure epitaxial thin films of a perovskite 4*d* transition metal oxide $SrMoO_3$ were investigated via XANES and XMCD. $SrMoO_3$ is the one of the most promising transparent conducting oxides, where electron correlation effects can be used to tune the optical gap of the material. It is commonly believed that $SrMoO_3$ is a Pauli paramagnet and exhibits strongly enhanced magnetic susceptibility of $2 \cdot 10^{-4}$ cgs/mole and an upturn below 20 K. This magnetic behaviour as a function of temperature was earlier hypothetically assigned to the presence of impurities and has never been thoroughly studied [1,2].

$SrMoO_3$ thin films for this study were deposited by pulsed laser deposition on $SrTiO_3$ substrates. Absorption spectra were recorded using the total fluorescence yield detection mode. The measurements were performed at 295 and 2.1 K to monitor changes of the magnetic moment with temperature. The XMCD spectra for $SrMoO_3$ were obtained as direct difference between consecutive XANES scans recorded with opposite helicities of the incoming X-ray beam.

The XANES and XMCD spectra of the Mo $L_{2,3}$ edges, recorded at the incidence angle of the X-ray beam of 15°, magnetic field of 17 T, and the temperature of 2.1 K are shown in Fig. 1(a). The Mo $L_{2,3}$ XANES spectra recorded at positive and negative helicities of the x-ray lights are nearly identical and therefore, no XMCD signal has been obtained (Fig. 1(a)). Thus, the magnetic moment of the $SrMoO_3$ film at 2.1 K is below the resolution of the experimental setup and cannot be measured. The Mo L_3 XANES spectra recorded at 295 K are nearly identical too. At the temprature of 295 K, the recorded Mo L_2 XANES spectra were affected by artefacts such as Bragg reflections from the substrate and could not be used for calculations of the magnetic moment. Similar results were obtained at normal incidence of the X-ray beam.

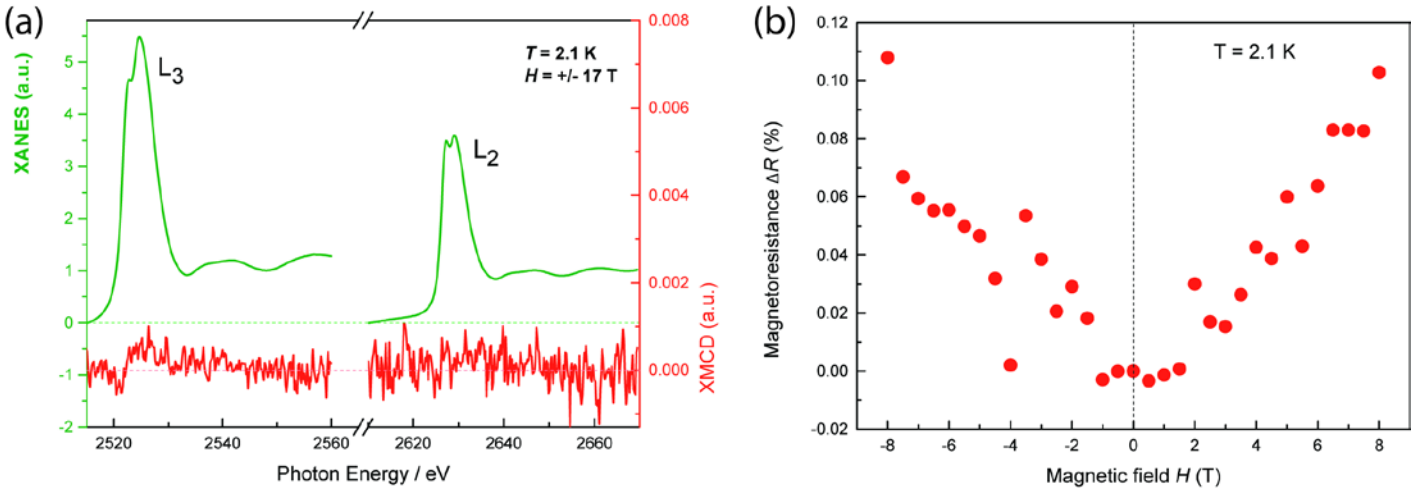

Fig. 1. (a) XANES and XMCD spectra of a 400 nm thick $SrMoO_3$ film on $SrTiO_3$ substrate recorded at the incidence angle of the X-ray beam of 15°, magnetic field of 17 T and the temperature of 2.1 K. (b) Magnetoresistance of the $SrMoO_3$ film at 2.1 K.

Thus, the small amount of the film material and the parasitic Bragg diffraction peaks from the substrate were limiting factors for the experiment. Moreover, a low circular polarization rate of 14% at the L_3-edge and of only 5% at the L_2-edge could lead to an insufficient measurement XMCD sensitivity for the used $SrMoO_3$ thin-film samples.

The results of the magnetoresistance measurements of the $SrMoO_3$ films are shown in Fig. 1(b). A small positive magnetoresistance of $SrMoO_3$ of approximately 0.11% is observed at the magnetic field of 8 T. Based on the performed measurements of the Hall effect in the $SrMoO_3$ films, the following parameters have been calculated for the $SrMoO_3$ films: a number of holes in the Mo 4d shell of 7.047, an electron concentration of 4×10^{22} cm^{-3}, and electron mobility of 7 $cm^2V^{-1}s^{-1}$ at 4.2 K.

In summary, no XMCD signal has been detected from the $SrMoO_3$ films at 2.1 and 295 K, presumably due to a low amount of the material in the films, a low circular polarization rate of the X-ray beam, and the observed parasitic Bragg diffraction peaks at the investigated Mo $L_{2,3}$ edges, which originate from the used thick single-crystalline substrate. The anomalous increase of the paramagnetic susceptibility at low temperatures has not been observed.

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