Growth of Thin Films of Charge Density Wave System $K_{0.3}MoO_3$

Andrej Tomeljak[1,2], G. Socol[3], C. Ristoscu[3], Ion N. Mihailescu[3],D. Dominko[4], D. Starešinić[4], K. Biljaković[4], J. Marcus[5], J. Demšar[1,2,6]

[1] Department of Complex Matter, Jožef Stefan Institute, Ljubljana, Slovenia

[2] Jožef Stefan International Postgraduate School

[3] Laser-Surface-Plasma Interactions Laboratory, Lasers Department, National Institute for Lasers, Plasma and Radiation Physics, PO Box MG-54, Bucharest-Magurele, Romania

[4] Institute of Physics, HR-10001, Zagreb, P.O. Box 304, Croatia

[5] Institut Neel, CNRS, BP 166, F-38042, Grenoble, Cedex 9, France

[6] Department of Physics and Center for Applied Optics, University of Konstanz, D-78457 Konstanz, Germany

andrej.tomeljak@ijs.si

Following early work by van der Zant et al. [1], we prepared high-quality epitaxial thin films of charge density wave (CDW) system $K_{0.3}MoO_3$ on different substrates. CDW is a spatially modulated superstructure of conducting electrons, which can form in quasi one dimensional systems. $K_{0.3}MoO_3$ undergoes a phase transition to a 3D CDW ordered state at 183 K. In continuation to the femtosecond spectroscopy performed in [2-4], new studies of femtosecond time-resolved Terahertz conductivity dynamics, necessary to directly probe the relaxation processes of photo-excited carriers, need high-quality thin films.

The films were grown by pulsed laser deposition with an excimer laser system COMPexPro 205 (Lambda Physik). The morphology and composition of the films was tuned by changing the deposition parameters: the substrate temperature, the partial oxygen pressure and the number of laser pulses. The optical properties of the films were characterized using FTIR and UV-Vis spectrometers. By systematically changing the deposition parameters, we were able to find a narrow window of parameters that yielded films with optical properties that matched those calculated for $K_{0.3}MoO_3$ films.

The best films were further characterized. Their electrical properties were determined by temperature dependent DC resistivity measurements. The film resistivity showed similar activated behavior as large crystals, however the transition was not as sharp. The final proof of film composition and of the CDW transition was obtained by means of femtosecond spectroscopy. The films were photoexcited by a femtosecond optical pulse and the resulting relaxation dynamics was measured by following the dynamics of changes in the dielectric function as a function of the time delay after perturbation. By comparing the signal with the corresponding signal measured in a $K_{0.3}MoO_3$ crystal [3,4], we were able to prove not only the $K_{0.3}MoO_3$ composition but also the CDW formation.

References:

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