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uz sljedeći

D n e v n i r e d:

1. **Izlaganja stipendista za MCM2017:**

Teodoro Klaser, PMF Fizika: Nanoworld of acrobatic crystals – thermosalient effect (example of Scopolamine bromide)

Daniel Meljanac, IRB: Structural investigation of nanocrystalline ZnO:Al thin films deposited by PLD in RF excited oxygen atmosphere

Ivana Panžić, IRB: Zinc oxide for photovoltaic applications

2. **Razno**

Tajnica:
Jelena Macan

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Nanoworld of acrobatic crystals – thermosalient effect (example of Scopolamine bromide)

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Keywords: Thermosalient effect, Scopolamine bromide, Phase transition

Imagine the surprise on one's face when, during the microscopic evaluation of the crystals' habits, these crystals start to literally jump and fly on the stage providing a vivid example of thermosalient effect. Thermosalient materials are the ones that during heating/cooling undergo an energetic phase transition which is so sudden and abrupt that the crystals are ballistically projected to heights of several hundred times larger than their own dimensions. Apart from providing visually extremely attractive phenomenon, these materials have a tremendous technological potential as the future self-actuation device (nanoswitches, thermal sensors, artificial muscles, etc.)[1]. Several exciting experimental studies on the origin of the thermosalient effect were published resulting in an astonishing wealth of information about the effect, but still we are far from the full understanding of the peculiarities and all the interplays and forces that govern this phenomenon. Here we present a systematic experimental study of the thermosalient effect in Scopolamine methyl bromide. As in most of the thermosalient systems, immense negative thermal expansion seems to be the most likely candidate for the driving force behind this phenomenon. This study presents combination of optical and electron microscopy, together with the x-ray diffraction measurements. Optical microscopy provides a direct insight into this visually extremely attractive phenomenon which is a manifestation of the macroscopic transformation of thermal energy into mechanical work. This analysis gives us a wealth of information about mechanical behaviour of thermosalient crystals – the macroscopic change of the crystal habit during the transformation, their trajectory, initial velocity and the dependence of the jumping height on the heating rate. On the other side, high resolution transmission electron microscopy gives us an insight into the fine details of the crystal structure and the stress field which is responsible for the thermosalient effect. These two microscopic techniques, coupled with the *in situ* non-ambient x-ray powder diffraction measurements, enable us to fully elucidate the thermosalient phenomenon in this system.

References:

1. Skoko, Ž. et al., J. Am. Chem. Soc., 2010, 132 (40), pp 14191–14202

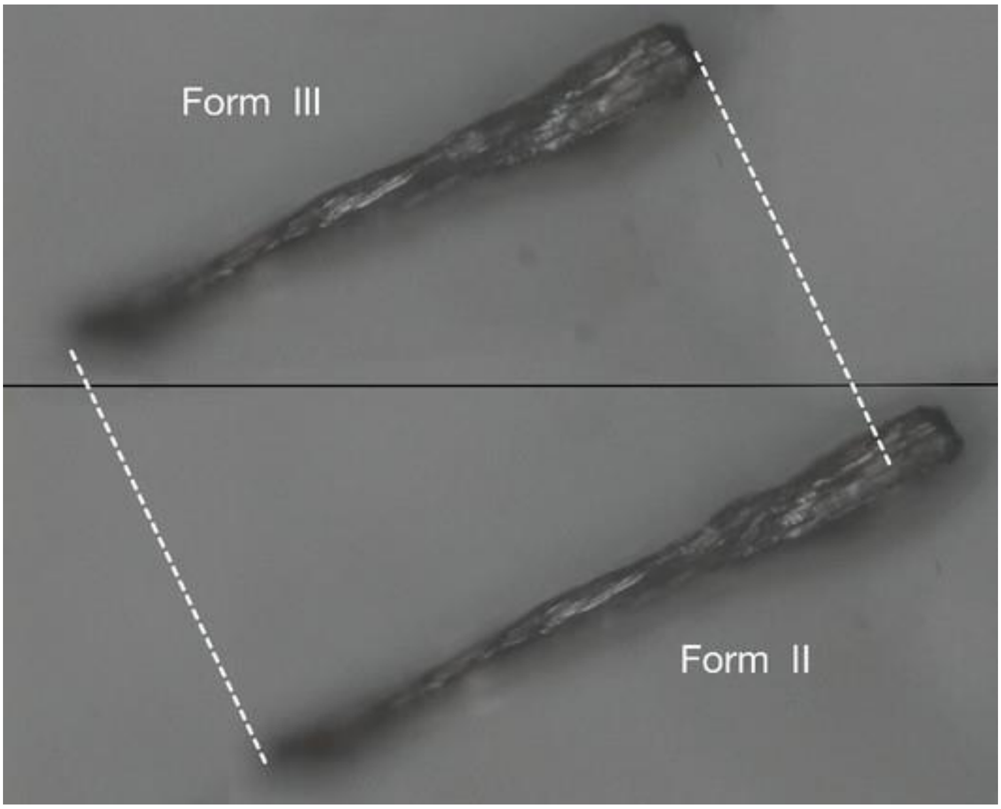

Figure 1. Change of the crystal's microscopic dimension during the thermosalient phase transition.

Structural investigation of nanocrystalline ZnO:Al thin films deposited by PLD in RF excited oxygen atmosphere

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Nanocrystalline Al-doped ZnO thin films were deposited in vacuum and in oxygen atmosphere with and without RF excitation by pulsed laser deposition (PLD). The gas pressures during deposition were varied between 10 and 70 Pa in order to investigate the influence on structural properties and point defect dynamics. The surface structures were monitored by atomic force microscopy (AFM) and field-emission-gun scanning electron microscope (FEG-SEM), while the obtained nanostructural changes were analyzed by x-ray scattering at grazing incidence angles. The imaged surfaces, obtained from AFM, are not homogenous and flat, but show a granular structure. The surface roughness mostly follows the trend, where the roughness increases with the oxygen pressure, and also by applying RF excitation. Grazing incidence small angle x-ray scattering (GISAXS) and grazing incidence x-ray diffraction (GIXRD) showed also the trend, that the roughness of film surfaces increases with increasing gas pressure, and the density decreases due to the formation of nanovoids. The nanocrystals sizes estimated from GIXRD were around 20 nm, while the sizes of the nanovoids increased from 1 to 2 nm with the oxygen pressure. Furthermore, as seen from the SEM micrographs, various larger particles are present on the surface, possibly as a consequence of droplet formation in the laser plume. The samples deposited under vacuum condition and at lower pressures, contain on the surface nanostructures with cylindrical shape, hollow at lower pressures, while solid at higher pressures. At 70Pa, the cylindrical shapes turned to spherical. The addition of excited oxygen particles from a RF plasma improves the structural ordering by lowering the defect level, which is evident from GISAXS and photoluminescence (PL) measurements. The PL consisted of 3 well defined peaks, UV emission that corresponds to a band-to-band transition, blue emission that appeared due to Zn vacancies, V_{Zn}, and red emission that is probably due to oxygen interstitials, O_i. For all pressures the RF excitation lowered the defect level related to blue emission and resulted in a narrower UV luminescence peak, indicating better structural ordering. The red emission peak is only seen using a RF excited oxygen atmosphere at 70Pa. The observed influence of the pressure and RF excitation on the films properties is a consequence of two main effects: the variation of the energy transfer from the laser plume to the growing film due to a different collision rate in the gaseous phase and changes of the growth chemistry due to various concentrations of active oxygen species.

Acknowledgements:

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Zinc oxide for photovoltaic applications

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Keywords: zinc oxide, aluminium doped, sol-gel, SEM, GIXRD

Zinc oxide as a wide bandgap II-IV semiconductor is a promising material for many device applications such as solar cells, thin film transistors, chemical and biological sensors. For the application of ZnO as a transparent conducting electrode in solar cells it is important to develop low resistivity films with high transparency in the visible region and high stability against heat. ZnO films have a lot of advantages over widely used indium tin oxide film such as low cost, non-toxicity and high stability in atmosphere with good electrical and optical properties. The influence of preparation procedure and morphology on the electrical properties of the ZnO thin films modified by doping with aluminium were studied. The ZnO and Al doped ZnO (AZO) films were prepared on glass substrates by the sol-gel spin coating method using zinc acetate dihydrate-isopropanol-monoethanolamine sol doped with 1, 2, or 3 at % of Al with respect to Zn. The sol was aged for 24, 48, 72 h and 7 days before the spin coating process. The films were deposited 5,10,15, 20, 25,30 times, with heating for 5 minutes on 150 °C between the layers. When the desired number of layers was deposited, the films were annealed at different temperatures and different heating rates to investigate the influence of the annealing process on the morphological, structural and electrical properties. The morphological, structural, electrical and optical properties of post annealed films were investigated. For the morphological and structural characterization scanning electron microscopy (SEM) techniques, grazing incidence X-ray diffraction (XRD), Raman spectroscopy and FTIR were used. For the optical characterization UV/VIS spectroscopy measurements of transmittance and absorbance were performed.

AZO transparent conductive films with low resistivity and excellent transparency in the visible range were prepared by the sol-gel method. The fabricated films are believed to have great potential in the solar cell applications instead of the commonly used ITO and FTO substrates. Moreover, it was observed that the post annealing temperature and rate of heating influence morphology of the AZO (Figure 1 and Figure 2). Therefore, the sol-gel procedure combined with post-annealing treatment could be also used as the new method for preparation of electron transport layers in solar cells.

Acknowledgements:

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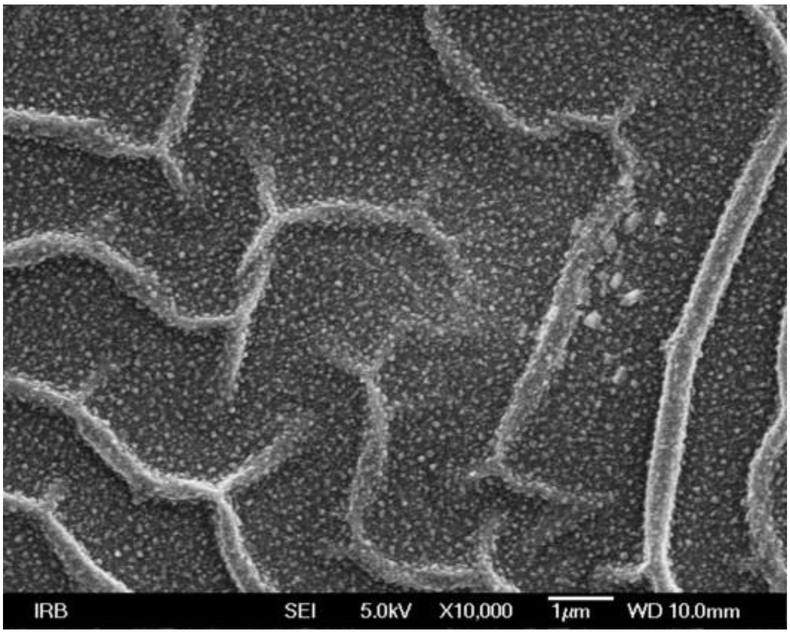

Figure 1. AZO thin film, annealed at 500°C, heating rate 50°C per minute.

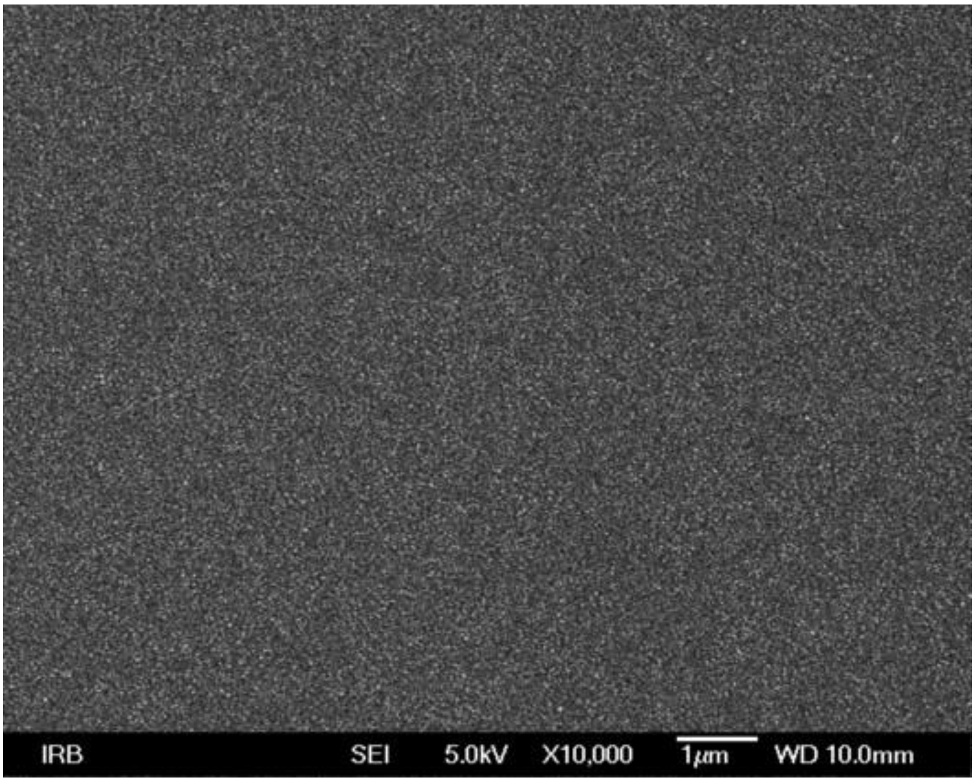

Figure 2. AZO thin film, annealed at 400°C, heating rate 2°C per minute.