Nanostructured surfaces

9th International Workshop on Surface Physics

organized by

Institute of Experimental Physics University of Wrocław



24 – 28 June 2019 Trzebnica, Poland

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• • Oral Presentation



STRUCTURAL AND MAGNETIC PROPERTIES OF TRANSITION METAL OXIDE THIN FILMS GROWN ON Ru(0001)

<u>A. Mandziak</u>^{1,4}, J. de la Figuera¹, G. Delgado¹, M. Sanchez¹, P. Prieto², J. E. Prieto¹, A. Quesada³, M. Foerster⁴, L. Aballe⁴

- ¹ Instituto de Qumica Fisica Rocasolano, Madrid, Spain
- ² Dpto. de Física Aplicada, Universidad Autónoma de Madrid, Madrid, Spain
- ³ Instituto de Cerámica y Vidrio (CSIC), Madrid, Spain
- ⁴ Alba Synchrotron Light Facility, CELLS, Barcelona, Spain

Transition metal oxides (TMO) are promising candidate materials for future spintronic devices. Their properties arise from the interaction between transition metal and oxygen ions in a given structure which are very sensitive to different bond length and angles, as well as to their particular cationic distribution. However, their properties in thin film form, as required for the use in microelectronic devices, are often disappointing, since interface and surface effects, as well as defects can play strong roles. Thus, a detailed understanding of magnetic and transport properties of ultrathin films at such scale are needed, which enables us to optimize the fabrication methods.

Here we demonstrate a route for preparing high quality ultrathin ternary transition metal oxide films on a metallic substrate. Mixed nickel, iron and cobalt oxides have been grown on Ru(0001) by high temperature oxygen-assisted molecular beam epitaxy. The nucleation and growth process are observed in real time by means of Low Energy Electron Microscopy (LEEM), which enables to optimize of the growth parameters. A comprehensive characterization is performed combining LEEM and LEED for structural characterization and PEEM (PhotoEmission Electron Microscopy) with synchrotron radiation for chemical and magnetic analysis via X-ray Absorption Spectroscopy, X-ray Magnetic Circular Dichroism and X-ray Magnetic Linear Dichroism (XAS-PEEM, XMCD-PEEM and XMLD-PEEM, respectively).

Depending on the chosen stoichiometry and conditions, either spinel ferrites or monoxides of rocksalt structure can be prepared. The spinel ferrites show ferromagnetic contrast. While the monoxide one present long range antiferromagnetic ordering with the Néel temperature above the room temperature. The high crystalline and morphological quality of prepared films result in optimized properties with respect to films grown by other methods, such as magnetic domains which are larger by several orders of magnitude.

Poster Presentation





A NEW CUSTOM-MADE SAMPLE HOLDER FOR HIGH-TEMPERATURE AND IN SITU APPLICATION OF MAGNETIC FIELDS IN A PHOTOEMISSION ELECTRON MICROSCOPE

<u>A. Mandziak</u>^{1,2}, J. Prat², J. de la Figuera¹, J. E. Prieto¹, M. Foerster², L. Aballe²

We present a new custom-made sample holder system for its use in Elmitec Low Energy and PhotoEmission Electron Microscopes. It comprises two different sample holder bodies: one with a filament for electron bombardment heating up to more than 1500 K and another one with integrated electromagnets for the *in situ* application of small magnetic fields either inplane or out-of-plane. The sample itself is placed on a platelet with a central top hat shape which is transferred between both holder types. Thus it is possible to prepare or grow samples at elevated temperatures and then investigate their behavior under magnetic fields without ever leaving the ultra-high vacuum system.

This design opens up new possibilities for the study of magnetic properties of surfaces, thin films and nanostructures which cannot be exposed to air. As an example of the performance of the setup we present the growth of magnetite on Ru(0001) by high temperature oxygen-assisted molecular beam epitaxy. The nucleation and growth process are observed in real time by means of Low Energy Electron Microscopy (LEEM), which enables to optimize the growth parameters. Imaging of the magnetic domain distribution of the resulting magnetite microstructures is done via XMCD-PEEM (X-ray Magnetic Circular Dichroism Photoemission Electron Microscopy). Finally, the switching characteristics of individual magnetite microstructures under applied field was investigated. Our results illustrate the feasibility to change the magnetic state of the *in-situ* grown materials at tens of nm scale resolution.



Figure 1. 3D model of the design of hightemperature part of exchangeable sample holder.

¹ Instituto de Química Fisica Rocasolano, Madrid E-28006, Spain

² Alba Synchrotron Light Facility, CELLS, Barcelona E-08290, Spain