Web Summary Report

January 2014 – December 2014

Phase IV

In the fourth stage of the project the studies were focused on the growth and characterization of multifunctional zinc oxide thin films (Part A). In order to enhance an existing physical property or to induce a new one doped ZnO thin films have been grown with twofold strategy: having a “passive” and an “active” functionality, for applications. Optical properties of zinc oxide thin films grown under different conditions were investigated and discussed.

These studies have continued on those carried out in the previous Phase, where we have investigated electrical properties in the various areas of a zinc oxide thin film, obtained in a single process, using a mechanical obstacle in the path of the ablation plasma plume. High optical transparency in the visible range was obtained for these multifunctional zinc oxide thin films. The ZnO thin films have a transmittance of ~90-98% (without substrate) in the visible wavelength range (350-750nm) for the region behind the obstacle and ~90-95% in the adjacent regions, for the same wavelength range. The band gap of the ZnO film, obtained by Tauc's plot was ~3.27 eV in the region behind the obstacle and ~3.29 eV in the adjacent regions. These results were compared with the model system, In_2O_3 thin films. Measurements of the photoluminescence properties of the thin films have been also performed, demonstrating thetest2014 “active” role for applications.

These applications require large area thin films for which non-uniformities at large scale in film thickness, composition and film properties should be avoided. Due to the very anisotropic expansion dynamics of the plasma plume, non-uniformities in film thickness, stoichiometry, lattice parameter and the texture of zinc oxide films were evidenced as a function of position on the substrate, i.e. on the oblique incidence of the ablated species.

A bell shape curve of the normalized thickness was observed as a function of the deposition angle. Such an angular distribution of thickness has been usually observed for a lot of materials deposited by ablation. Moreover, the O/Zn composition ratio varies as a function of the substrate position, leading to the formation of three zones. For the region I (central region of the film) largely

oxygen deficient zinc oxide is formed. For increasing deposition angle (region II), the oxygen deficiency in the film decreases, corresponding to an increase of the O/Zn ratio of fluxes. A further increase of this ratio leads to the formation of stoichiometric ZnO in the region III (peripheral region of the film).

Details about results obtained in this Phase can be found in following papers presented in the Dissemination section.

Dissemination

M Nistor, W. Seiler, C. Hebert, E. Matei, J. Perrière, Appl.Surf.Sci. **307**, 455 (2014).

J. Perrière, C. Hebert, N. Jedrecy, W. Seiler, O. Zanellato, X. Portier, R. Perez-Casero, E. Millon, and M. Nistor, J. Appl. Phys. **116**, 123502 (2014);

F.Gherendi, J.Optoel. Adv. M. **15** (No. 11-12), 1463 (2013)

and in 7 communications at international conferences.

In conclusion the objectives of Phase IV were realized, resulting multifunctional zinc oxide thin films for applications.