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Characteristics of amorphous transparent and conductive oxides grown by combinatorial pulsed laser deposition

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Amorphous and transparent semiconductor oxides are key components of new thin film transistors (TFTs), solar cells electrodes and displays. By controlling their stoichiometry, they can be used as TFT channel (semiconductive behavior) or as transparent electrode (conductive behavior). Recently, room temperature deposited indium zinc oxide (IZO) and indium gallium zinc oxide (IGZO) thin films were shown to exhibit very good transparency in the visible range, low resistivity, and high mobility. Since the optical and electrical properties of these films depend on the In/(In+Zn) and Ga/(In+Ga+Zn) values, the accurate measurement of these ratios is important for future developments and applications.
In this presentation we focus on the relationship between composition and properties of IZO and IGZO thin films synthesized using the Combinatorial Pulsed Laser Deposition technique. An accurate monitoring of the thin films elemental composition was performed by Laser-Induced Breakdown Spectroscopy (LIBS) based on plasma modeling in view of further in-situ and real-time technological developments and process control in case of ASOs fabrication. The cation fractions measured by LIBS were compared to values obtained by complementary measurements using Rutherford backscattering spectrometry, energy dispersive X-ray analysis and X-ray fluorescence.
The optical properties (thickness profile and refractive index determination) of the thin films were inferred from spectroscopic ellipsometry data acquired in the visible range and optical reflectance measured from 30 cm-1 (4 meV) to 30 000 cm-1 (4 eV). Complementary investigations to obtain the thickness and density of the deposited films as well as their surface and interface roughness have been performed by fitting the measured X-ray reflectivity and X-ray diffuse scattering curves with simulated ones using dedicated models. The room temperature electrical properties were investigated using typical four-point probe geometry and Hall measurements and compared with the values estimated from the optical reflectance data. X-ray photoelectron spectroscopy was used to measure the energy discontinuities in the valence and conduction bands of various dielectric/IGZO and dielectric/IZO heterostructures. All these measurements helped design better transparent and conductive oxides containing lower amounts of In, an element that is rather scarce and therefore expensive.

Are you currently a postgraduate student? (Yes/No)

No

Primary author: Dr CRACIUN, Valentin (National Institute for Laser, Plasma and Radiation Physics)

Presenter: Dr CRACIUN, Valentin (National Institute for Laser, Plasma and Radiation Physics)

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