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ZINC OXIDE MATERIAL FOR OPTOELECTRONIC APPLICATIONS

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ABSTRACT

This work presents some electronic and optoelectronic applications referring to the ZnO zinc oxide material. In materials science ZnO included in semiconductor II-VI group, has favorable semiconductor properties, such as: good transparency, high electronic mobility, wide bandgap, high brightness at room temperature, etc. These properties are already being used in developing applications for transparent electrodes in liquid crystal displays and to save electricity or heat, protect windows, etc. Important applications of zinc oxide films and microstructure examination as well as manufacture techniques are briefly discussed. Special attention has been paid to the effects of the microstructure and composition on the zinc oxide thin films properties, and various characterization techniques are reported.

Keywords: thin film transistors, light emitting diodes, photocatalyst, SEM, FTIR.

INTRODUCTION

ZnO is a high energy excitation (60 MeV) high-energy (3.37 eV) high-energy semiconductor material that provides ultra-violet emission exciton regions efficiently at room temperature. This bandgap corresponds to a wavelength of 328 nm, within the UV light range and is transparent to visible light as well as to the most widely used wavelengths in optical technologies. These properties combined with the piezoelectric effect make ZnO a unique, complete, perfect material for electronic and optoelectronic applications. ZnO is also biodegradable and biocompatible. Since 2009 ZnO's electronic future applications are for *thin film transistors* and *light emitting diodes*.

Also, ZnO was used as photocatalyst due to its high photosensitivity, non-toxic nature, stability and wide band gap. Photocatalytic activities of pure and doped ZnO were investigated for degradation of Malachite green (MG) (bis[p-dimethylaminophenyl] phenyl-methylium oxalate) solution (Lavand, 2016). In order to enhance photocatalytic activity in the visible region it is necessary to modify ZnO, by various ways such as doping it with metals or non-metals and coupling it with other semiconductors (Malghe, 2016). Semiconducting metal oxides such as ZnO and Cu_2O are promising candidate materials for implementation in photovoltaic applications. The Aluminum doped ZnO (AZO) thin films indicate a high transparency in the visible region and these transparent AZO films may be open a new avenue for optoelectronic and photonic devices applications in near future (Ghamdi, 2014). XRD patterns have shown that the films crystallize in a hexagonal wurtzite type, and the grain sizes decrease with increasing Al doping (Taabouche, 2016).

The methods used to study the evolution of powder crystallization properties are: Non-Isothermal Differential Scanning Calorimetry (DSC), Spectroscopy of RAMAN, FTIR Spectroscopy (PCS), Spectroscopy of Photon Correlation Spectroscopy (PCS) Fourier Transform Infrared Spectrometry (FTIS), X-ray diffraction, Scanning force microscopy

(SFM). Analysis of SEM images of powders and thin films obtain important data related to: *granulation, porosity, material defects, profiles, roughness, 3D viewing, thickness of layers deposited on the support, etc*. The composition of the films is analyzed with special procedures (EDAX, AES and ICP).

Table 1 - Optical characteristics of some materials

Material	**Band gap, [eV]**	**Approx. wavelength threshold, [nm]**	**Material**	**Band gap [eV]**	**Approx. wavelength threshold, [nm]**
	Elements			**Chalcogenics**	
Si	1.12	1107	**CdS**	2.42	512
Ge	0.66	1879	**CdSe**	1.70	729
	Oxides		**CdTe**	1.50	827
TiO_2 (rutil)	3.00	413	**ZnS**	3.2	388
(anatase)	3.15	370	**ZnSe**	2.58	481
ZnO	3.35	394		**Groups of III-V components**	
WO_3	3.2	388	**GaAs**	1.43	867
MoO_3	2.9	428	**GaP**	2.24	554
Fe_2O_3	2.2	564	**InAs**	0.33	3758
SnO_2	3.8	326	**InP**	1.29	960

RESULTS AND CONCLUSIONS

Important applications of zinc oxide films and microstructure examination as well as manufacture techniques are briefly discussed. Special attention has been paid to the effects of the microstructure and composition on the zinc oxide thin films properties, and various characterization techniques are reported.

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