OMN100-55 (1)

Photosensivity of heterostructures produced by aerosol deposition of ZnMgO thin films on Si substrates

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Keywords: ZnO, ZnMgO, UV irradiation, photocurrent, photosensitivity.

Summary:

ZnMgO thin films were prepared on Si substrates by aerosol deposition method using zinc acetate and magnesium acetate as precursors. The obtained films were investigated by scanning electron microscopy (SEM), energy dispersive x-ray (EDX) and X-Ray Diffraction (XRD). SEM and EDX analysis showed that the produced thin films are homogeneous from the point of view of morphology and composition. It was found that annealing at 500 ^{o}C leads to the production of macroscopically homogeneous wurtzite phase films, while thermal treatment at lower or higher temperatures results either in the formation of ZnO particles embedded into the ZnMgO matrix, or in degradation of the film morphology. The investigation of photosensitivity demonstrated that the heterostructures of ZnMgO thin films deposited on Si substrates are sensitive in a wide spectral range from ultraviolet (UV) to infrared (IR) radiation, with a highest sensitivity in the UV region.

Motivation

ZnMgO solid solutions system presents interest due to possibilities to tailor many important physical properties by varying their composition. This alloy system covers a wide ultraviolet (UV) spectral range between the direct bandgaps of 3.36 eV for ZnO and 7.8 eV for MgO at room temperature, therefore being very attractive for short-wavelength optical applications such as UV detectors [1-3] and light emitters [4-6]. The $Mg_xZn_{1-x}O$ system [7,8] provides the possibility to model the optical, luminescent and photoelectric properties in a wide spectral range, by adjusting the composition in the system (x-parameter value). Devices for short wavelengths UV-A (320-400 nm), UV-B (280-320 nm) and UV-C (200-280 nm) radiation can be produced by changing the composition [9]. Nanostructuring of these materials, particularly the production of nanostructured films, is an additional element for modeling specific properties.

Results

After deposition of the thin film by means of aerosol deposition, the aluminum contact was evaporated on the backside of the Si substrate. Front-side contacts were fabricated by depositing palladium trough a specially designed mask with 1.5 mm diameter in high vacuum with pre-heating of sample at temperature of 300 °C during 1 hour in the installation VUP-4. The morphology and chemical composition analysis of the deposited layers was investigated using Scanning Electron Microscope (SEM) Zeiss LEO Gemini 1530 equipped with an Oxford Instruments INCA Energy EDX system operated at 20 kV. The XRD patterns of the prepared thin films were investigated with a Rigaku Smart Lab X Ray Diffractometer using Cu K_α radiation (λ=0.15406 nm). The radiation from a Xenon lamp DKSS-150 was used to excite the photoconductivity in ZnMgO layers (*Figure 1*). Optical filters were used to select radiation from different spectral ranges (ultraviolet: 300–400 nm, power density at the sample surface 17.6 mW/cm^2; visible 400–700 nm, power density 25.5 mW/cm^2; and infrared 700–2500 nm, power density 134 mW/cm^2). The samples were illuminated with a focused beam of 5 mm in the diameter. The current through the samples was measured by means of a Keithley's Series 2400 Source Measure Unit. A mechanical shutter was used in the PC relaxation experiments. The signal from the Source

Measure Unit was introduced in an IBM computer via IEEE-488 interface for further data processing. The measurements were performed at room temperature (300 K) in vacuum.

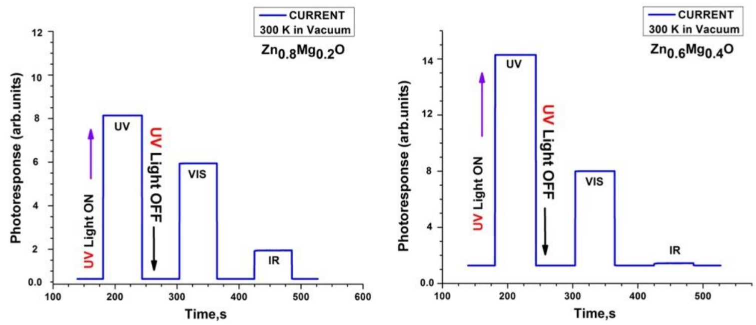

Figure 1. *The photoresponse measured at 300 K in vacuum with radiation of different wavelengths for $Mg_xZn_{1-x}O$ films with x = 0.2 and x = 0.4 deposited on Si substrates*

Acknowledgement

This work was supported financially by the National Agency for Research and Development of the Republic of Moldova under the grant no. 19.80013.50.07.02A/BL, VM thanks to the DAAD scholarships (German Academic Exchange Service) for support.

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4*. Micro/ nanophotonics and micro/ nanotechnologies*

Poster