

Ag Doping Effects on the Microstructure, Morphology, Optical, and Luminescence Properties of Sol–Gel-Deposited ZnO Thin Films

© M. Atoui¹, S. Benzeghda², T. Touam^{3,¶}, A. Chelouche⁴, D. Djouadi⁴

¹ Radiation and Plasma and Surface Physics Laboratory, University Kasdi Merbah Ouargla, Ouargla 30000, Algeria

² Microsystems and Instrumentation Laboratory, Department of Electronics, University Mentouri Constantine, Constantine 25000, Algeria

³ Semiconductors Laboratory, University Badji Mokhtar-Annaba, Annaba 23000, Algeria

⁴ Laboratory of Environmental Engineering, University of Bejaia, Bejaia 06000, Algeria

¶ E-mail: touamt@gmail.com

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A sol–gel dip-coating process is used to prepare highly *c*-axis-oriented thin films of zinc oxide (ZnO) on glass substrates. The effects of moderate Ag doping (Ag:Zn < 10%) on the microstructural, morphological, optical, and luminescence properties of such films are investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM), atomic force microscopy, UV-Visible (UV-Vis) spectrophotometry, and photoluminescence (PL) spectroscopy. Interesting results were obtained, *e.g.*, XRD analysis shows that all the films possess a polycrystalline wurtzite structure with a *c*-axis preferential orientation, and exhibit a minimum residual stress. The crystallite size values are calculated and found to be about 20–24 nm. Raman spectra of the films confirm XRD data analysis. SEM micrographs and AFM images show a dense surface with more or less spherical grains uniformly distributed. Moreover, it is found that increasing Ag doping levels leads to a decrease in grain size and surface roughness. According to UV-Vis measurements, the non-doped ZnO thin film is highly transparent in the visible region with an average transmittance of about 83%. As the concentration of the doped Ag increases, the transmission slightly decreases. Moreover, the direct optical band gap is found to increase with increasing Ag doping concentration. Room temperature PL spectra put into evidence that emission is found to be influenced by Ag content. The UV emission initially increased with increasing Ag doping up to 6% and then decreased, whereas the intensity of the visible emission decreased with the increase in the Ag concentration from 0 to 3% and then increased for higher concentrations. The high quality of *c*-axis-oriented Ag-doped ZnO thin films with minimum stress and tunable optical properties suggests that these films may have good applications in optoelectronics.

Keywords: ZnO:Ag thin films, sol–gel, microstructural properties, transmittance, photoluminescence, optoelectronic applications.

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