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J Mater Sci: Mater Electron
DOI 10.1007/s10854-015-4013-0

Thermal blooming and photoluminescence characterizations of sol–gel CdO–SiO_2 with different nanocomposite

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Received: 21 July 2015 / Accepted: 1 November 2015
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Abstract The CdO NPs was synthesized using the sol–gel method and the nanoparticles were characterized using an UV–Vis spectrophotometer, with shape and size were examined by SEM and XRD. The XRD analysis respects the Bragg's law and confirmed the crystalline nature of CdO nanoparticles. From the XRD, the average size of CdO NPs was found to be around 41 nm. The photoluminescence spectra of the CdO NPs, as recorded at room temperature, were excited at 300 nm wavelength. The broad emission peaks were between 600 and 650 nm (orange emission). The optical limiting performance of the nanocomposite was described in the sol–gel state. Also, this study has observed and studied the diffraction rings generated in CdO NPs using the same CW laser. The number of rings increases almost exponentially with an increasing volume fraction of SiO_2 in the nanocomposites. The refractive index change, Δn, and effective nonlinear refractive index, n_2, were found to be 10^{-4} and 10^{-8} cm^2/W, respectively. The effective nonlinear refractive index, n_2, was determined based on the observed number of rings. The threshold values of the CdO, CdO–2SiO_2 and CdO–5SiO_2 nanocomposites are 7.1, 6.55 and 6.34 mW, respectively. This large nonlinearity is attributed to the thermal effect. The present studies suggest that the nanocomposite is a potential candidate for optical device applications such as the optical limiters. The thermal blooming technique was applied to evaluate the thermo-optic coefficient and thermal diffusivity of the CdO NPs. In the thermal blooming experimental setup a transistor–transistor logic modulated CW laser of wavelength 532 nm was used as the excitation source.

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1 Introduction

Nanotechnology has specific physicochemical properties which may differ from bulk substances. Therefore, it plays a significant role in the generation of new products and applications through the development of nanoparticles (NPs). NPs provide novel prospects of commercial and scientific applications [1]. During the current years, CdO molecules in a nanometric scale as particle or thin film forms, it creates an interest in the scientific community due to its significant optical, electrical, chemical properties and catalytic action [2, 3]. It has wide application in the field of solar cell [4], electrochemical capacitors [5], nonlinear optics [6], thermal electricity [7] and gas sensors [8]. Moreover, different CdO nanostructures [9–14] and in thin film forms [15, 16] prepared from various techniques have been reported and the size, shape and various properties depend on the preparation method and process condition. However, work related to nanostructure stability in shape and size has not been reported so far, only theoretical simulation studies of CdO in bulk have been reported. However there appears to be no records of any CdO in different nanostructure forms. Due to the n-type degenerate semiconducting properties and transparency in the visible and NIR spectral regions, CdO films are extensively used in optoelectronic applications such as the transparent conducting oxides, solar cells, smart windows, optical communications, flat panel displays, photo-transistors, as well