Materials Research Bulletin 170 (2024) 112554

Contents lists available at ScienceDirect

Materials Research Bulletin

journal homepage: www.elsevier.com/locate/matresbu

Research Papers

The influence of temperature on structural and third order nonlinear properties of cadmium sulfide nanoparticle films prepared by chemical reaction method

Harith A. Hasan [a,c], Nadia A. Hussein Al-Assady [b], Hussain A. Badran [c,*], Raeed K. Alfahed [d], Khalid I. Ajeel [c]

[a] Department of Material Science, Polymer Research Centre, University of Basrah, Basrah, Iraq
[b] Department of Chemistry, College of Education for Pure Sciences, University of Basrah, Basrah, Iraq
[c] Department of Physics, College of Education for Pure Sciences, University of Basrah, Basrah, Iraq
[d] Al-Nahrain Renewable Energy Research Center, Al-NahrainUniversity, Jadriya, Baghdad, Iraq

A R T I C L E I N F O

Keywords:
CdS-NPs
Optical properties
Energy band gap
Z-scan technique
Optical limiting behaviours

A B S T R A C T

In this work Cadmium sulfide nanoparticles)CdS-NPs(was deposited on glass substrates using a polymerassisted chemical reaction method (CRM) and annealed at different temperatures, 300∘*C*, 400∘*C*and 500∘*C*. The structural and optical characteristics of CdS-NPs films were investigated using X-ray diffraction (XRD), FTIR analysis, UV–Vis absorption spectroscopy and scanning electron microscopy (SEM). X-ray diffraction (XRD) and selected area electron diffraction studies confirmed the formation of nanocrystalline cubic phase of CdS in the films. The calculation shows that the CdS crystallized in cubic phase and formed NPs with average crystallite sizes of 17.2, 20.1 and 23.3 nm and the microstrain is about 0.034, 0.030 and 0.026 for CdS films annealed at 300∘*C*, 400∘*C* and 500∘*C*. The UV–Vis spectrophotometer measurements showed that the films were highly transparent value of 97 % at annealing temperature of 300∘*C*and 400∘*C*. The direct allowed bandgaps have been determined and they lie in the range 2.49 -205 eV for CdS-NPs film annealed at temperatures of 300 ∘*C*–500∘*C*. The thermal non-linear refractive indices (n_2) of the CdS-NPs are determined using open and closed aperture Z-scan techniques. The optical limiting (OL) behaviours have been studied. It was shown that the OL efficiency depended on the CdS-NPs temperature. Under laser irradiation, self-diffraction rings were seen in CdS-NPs-300∘*C*, CdS-NPs-400∘*C* and CdS-NPs-500∘*C*. With increased input power, each pattern is created by a rise in the number of rings and the diameter of the outermost ring. The aim of the current project studies is to investigate the linear and nonlinear optical characteristics to find fresh applications for CdS-NPs in the world of optical modulators.

1. Introduction

The nanoparticle materials of II-VI group semiconductors have received considerable attention in recent years according to their of very unique physical properties (piezoelectricity, conductivity, magnetic and optoelectronics) and their importance in the development of current optical devices, such as light emitter diodes and solar cells [1]. Since nanoparticles have a wide number of surface atoms than bulk materials, low-dimensional semiconductors have novel properties that offer new ideas in excellent technological characteristics not present in bulk materials [2–5]. In our knowledge, buffer layer materials must meet the parameters of a perfect band gap, excellent transmittance, and low resistance to get high transmission and uniform to avoid short circuit effect in the optoelectronic devices [6–11]. Various structures are starting from zero- dimensional nanoparticles such as nanotubes, nanorods, nanowires and nanobelts have been obtained from various nanomaterials. In particular nanostructure CdS films have received considerable attention according to their expected gap emission lies very close to the highest sensitivity of human eyes. Thus could be assuming that CdS nanostructure films are an appealing host of photonic systems [12–14]. The investigation of surface morphology and the uniform dispersion of the films result in desired features that may be used in a variety of contexts, this includes its employment in optoelectronic devices. CdS materials are n-type semiconductors and possess unique

* Corresponding author.
E-mail address: hussain_badran@yahoo.com (H.A. Badran).

https://doi.org/10.1016/j.materresbull.2023.112554
Received 18 February 2023; Received in revised form 21 September 2023; Accepted 2 October 2023
Available online 6 October 2023
0025-5408/