Determination of Optical and Thermal Properties of Nanoparticles using Photothermal SpectroscopyDetermination of Optical and Thermal Properties of Nanoparticles using Photothermal Spectroscopy

Ahmed khalid Abd Alkhalek Ghalia

Semiconductor nanoparticles have attracted a great deal of scientific interest recently, because of the sensitivity of their optical and non-radiative properties to their size. In this work, two groups of samples were prepared by the organometallic synthesis. The first one is CdSe and CdS quantum dots having different sizes, and the second is alloy CdSxSe1-x having different ratio between Se and S (x = 0.33, 0.5, 0.67, 0.75).We have employed the Photoascoustic spectroscopy (PAS) to study the optical and thermal properties of those samples. Photoacoustic technique is a photothermal detection technique; that is proved to be a powerful tool to study the optical, electronic, and thermal properties of such material in a nondestructive manner without particular sample treatment. It has been observed that the excitonic transitions of semiconductor nanocrystals are well resolved in PA spectra as compared to the corresponding optical absorption spectra.A complete theoretical treatment of the PAS technique is presented which includes the solution of the heat diffusion equation in the sample and surrounding media in case of front illumination. The temperature distribution within the PA cell and the production of the PA signal is presented. The PA signal is separated into two measurable quantities the amplitude and the phase having complicated expressions that can be simplified in the case of thermally thick samples.A theoretical treatment is introduced to semiconductor nanoparticles as intermediate between bulk and atomic regimes. We used the bottom-up approach to show the electronic structures. The effective mass approximation (EMA) is used to determine the size dependence of electron and hole energy spectrum in CdSe, CdS nanoparticles and the alloy CdSxSe1-x nanocomposite . The energy gap variations with size were obtained from the UV -Visible spectra and Photoacoustic (PA) spectra. It is found that there is blue shift of energy gap with decreasing the particle size in CdSe and CdS quantum dots that can be explained in terms of quantum confinement effects. Semiconductor alloy nanocrystals CdSxSe1-x of approximately the same size were fabricated by the chemical solution deposition technique. The observed exciton peaks in the UV -Visible spectra and PA spectra show an increased blue shift with the increase in molar ratio (x = 0 → 1). In this case EMA was applied to determine the size of the

nanocrystals using Vegard’s law applied to the bulk parameters. The calculated sizes of alloy nanocrystals using Vegard’s law are in a good agreement with the -directly measured values obtained using high-resolution transmission electron microscopy (HRTEM). The band gaps vary slightly for the alloyed nanocrystals having the same size but different molar ratio x.The thermal parameters (effusivity, diffusivity, and conductivity) were determined for CdSxSe1-x nanocomposite using the PA technique and compared to that of the corresponding bulk values. It is found that there is a remarkable increase in thermal parameters.