Hydrothermal synthesis and characterization of ZnS nanoparticles

R. Boulkroune*, *M. Sebais, M. Ayadi, O. Halimi

Laboratory of crystallography, Department of Physics, Mentouri University, Constantine, Algeria
riadboulekroune@yahoo.com

Abstract

Nanostructured materials have attracted considerable interest because of their unique physical properties and potential applications in optics and electronics. Zinc sulfide is a direct wide band gap semiconductor of the II-VI group; it is used in various applications such as light emitting diodes, flat panel displays, infrared windows, solar cell [1], photocatalysis [2].

In the present work, wurtzite ZnS nanoparticles have been successfully synthesized through a surfactant free hydrothermal method with a relatively low temperature (160°C) using zinc acetate ($Zn(CH_3COO)_2.2H_2O$) and thiourea $SC(NH_2)_2$ as zinc and sulfur source respectively. The reaction time was 8 hours. The obtained white powder was washed several times with deionized water and ethanol then dried at 50◦C for 2 h. On the other hand nanoparticles of ZnS were deposited on a glass substrate immersed in the autoclave.

The structural characterization of the as obtained ZnS nanoparticles was carried out using X-ray diffraction (XRD) and Raman spectroscopy while the optical properties of the deposited films were investigated by ultraviolet and visible absorption spectroscopy (UV-vis). The XRD results reveal that the ZnS nanoparticles exhibit the hexagonal wurtzite structure. The broad diffraction peaks profile indicates a low dimension of the ZnS crystallites. The average size of the ZnS crystallites was estimated using the Debye–Scherrer formula; it was found to be about 13 nm.The as prepared ZnS films exhibit a strong absorption in the UV range. The band gap of the as obtained ZnS nanoparticles was estimated to 3.7 eV; this indicates that the ZnS samples exhibit a quantum confinement effect with a blue shift in the band gap with respect to bulk ZnS. The Raman spectroscopy reveals vibrational modes which are specific to wurtzite structure of ZnS that confirms the XRD results.

Keywords: Hydrothermal synthesis, Nanoparticles, ZnS semiconductor, X-ray diffraction, UV-visible absorption, Raman spectroscopy.

References

[1] Sarute Ummartyotin, Yingyot Infahsaeng, Renewable and Sustainable Energy Reviews 55 (2016) 17–24

[2] Lixiong Yin, Dongdong Zhang, Dan Wang, Xingang Kong, Jianfeng Huang, Feifei Wang, Yabo Wu, Materials Science and Engineering B 208 (2016) 15–21