Quantum confinement effect in ZnO nanoparticles obtained by colloidal suspensions

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Nanoparticles of oxides of semiconductors has been of great interest in recent years. This is due to new physical and chemical properties of these materials at the nanoscale, especially the optical-electronic[1]. The literature refers to preparation of nanoparticles metal oxide using various techniques such as chemical precipitation, sol-gel and colloidal synthesis. In this work, zinc oxide nanoparticles with average size of 2 nm was prepared by colloidal method. Nanoparticles were obtained in colloidal suspension without addition of any dispersing agent, and as redispersable powders by liophilization.
The effect of quantum confinement was observed by UV-vis absorption spectroscopy. The particle average size was estimated by the effective mass model given by Brus[2],

$$E^* = E_g^{\text{bulk}} + \frac{h^2}{8er^2}\left(\frac{1}{m_e m_0} + \frac{1}{m_h m_0}\right) - \frac{1.8e}{4\pi\varepsilon\varepsilon_0 r} - \frac{0.124e^3}{h^2(2\varepsilon\varepsilon_0)^2}\left(\frac{1}{m_e m_0} + \frac{1}{m_h m_0}\right)^{-1},$$

where Eg is the bulk band gap, wich is approximately 3,2 eV, E* is the effective band gap energy, h is Plank's constant, r is the particle radius, m_e is the electron effective mass, m_h is the hole effective mass, m_0 is free electron mass, *e* is the charge on the electron, ε is the relative permittivity, and ε_0 is the permittivity of free space. Due to the small effective masses for ZnO (m_e=0.26, m_h =0.59) quantum effects are expected to occur for relatively large particle sizes. It was verified that there is closely relation between bandgap energy and nanoparticles size due to quantum confinement effect.

Keywords: Zinc oxide, colloidal chemistry, nanoparticles, quantun confinement, effective mas model,

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