Formation of CdS nanoparticles using starch as capping agent

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Abstract
CdS nanoparticles have been synthesized via a simple chemical bath deposition method. X-ray diffraction (XRD) shows that the as-prepared CdS nanoparticles have a high crystallinity and the morphology was measured by high resolution transmission electron microscopy (HRTEM). The average grain size of the nanoparticles determined by these techniques was of the order of *5nm,* which correlates well with the X-ray diffraction. We also reported Photoluminescence (PL) of CdS nanoparticles and the broadening peak was interpreted in terms of electron-phonon interaction.

Introduction
Quantum confined effects in semiconductor nanoparticles are known to make their optical and electrical properties significantly different from those of the bulk material, particularly when physical dimensions are reduced close to characteristic length known as the exciton Bohr diameter. These characteristic lengths are usually in the range of a few nanometers when the material exhibits size dependent optical and electrical properties. The protective polymer has to be carefully selected, since it can profoundly influence the particle sizes and morphologies of the resulting nanoparticles. The purpose of the present work is to develop an effective one-step method for the preparation of well controlled and uniform particle sizes of CdS nanoparticles using starch as capping agent in an aqueous solution. The obtained CdS nanoparticles were characterized by HRTEM, XRD and Photoluminescence. The results show that this system is mild, simple, stable and controllable.

Experimental Procedure
A microcrystalline mixture of starch and cadmium sulfide (CdS) were synthesized using was performed at 80 ºC, and the pH of an aqueous precipitation method. The growth method solution was used to 1% of the starch as capping agent.

Results
HRTEM images show of the spherical starch capped CdS nanoparticles and the amorphous matrix of the starch. And close-up of the CdS nanoparticle.
X-ray diffraction of CdS nanoparticles synthesized shows small crystalline. The XRD pattern exhibits three peaks at 26.5°, 43.9° and 52.1°, which correspond to (111), (220) and (311) planes in cubic phase of CdS.
The average grain size, as estimated from Scherrer's formula are in the range of 4-5 nm.

$$D = \frac{.94\lambda}{B\cos\theta}$$

The theoretical line shape of the PL energy in a quantum dot with radius *r* may be expressed as:

$$I(\hbar\omega) \propto \int g(r)|f(r)|^2 \delta\left[\hbar\omega - E^*(r)\right]P(r)dr$$

Where:

$$E^*(r) = E_g + \frac{\hbar^2\pi^2}{2\mu r^2} - \frac{1.8e^2}{\varepsilon r}, \quad \frac{1}{\mu} = \frac{1}{m_e} + \frac{1}{m_h}$$

$$g(r) = \begin{cases} 1 & for \quad r > \tilde{r} \\ \dfrac{2}{\left[1 + (r/\tilde{r})^2 \exp\left\{g(1/r^2 - 1/\tilde{r}^2)\right\}\right]} & for \quad r < \tilde{r} \end{cases}$$

$$P(r) = (2\pi)^{-1/2}\Delta^{-1}\exp\left[-(r-\tilde{r})^2/2\Delta^2\right]$$

Conclusions
The starch polymer can be used as an effective capping agent to synthesize CdS nanoparticles through chemical precipitation technique.
The crystal structure and grain size of the particles were determined using XRD through the Scherrer's formula.
The HRTEM images show the morfology of the starch capped CdS nanoparticles with size of the order of 5nm.
The PL studies can be explained by the combined effects of the size distribution of the nanoparticles and electron-phonon interaction.