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Optical characterization of CdS nanorods capped with starch

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HIGHLIGHTS

- Preparation of CdS nanorods with assistance of maize starch.
- The size of the nanorods has been controlled by changing the concentration of maize starch.
- CdS nanorods are uniform and of well crystalline.
- Absorbance peaks and emission peaks are shifted significantly for different samples.
- The optical band gap is being tuned by the size modification of the nanorods.

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ABSTRACT

Well crystalline uniform CdS nanorods were grown by changing the concentration of maize starch. The highly polymeric (branched) structure of starch enhances the growth of CdS nanorods. The average diameter of the nanorods is 20–25 nm while length is of 500–600 nm as verified from SEM and XRD observations. The optical band gaps of the CdS nanorods are varying from 2.66 eV to 2.52 eV depending on concentration of maize starch. The photoluminescence (PL) emission bands are shifted from 526 nm to 529 nm with concentration of maize starch. We have also observed the enhanced PL intensity in CdS nanorods capped with starch. The Fourier transform infrared (FTIR) spectroscopy shows the significant effect of starch on CdS nanorods.

Introduction

Semiconducting nanostructures research is one of the most investigated subjects due to their wide field of applications. The physical properties of nanostructures are strongly dependent on their size, especially on quantum confinement effects. In semiconductors, quantum confinement modulates the band structure and hence many properties can be tuned by changing the nanostructures size. Many research efforts have been done to investigate the physical properties of one-dimensional (1D) structures such as nanowires, nanorods, nanobelts and nanotubes [1–7]. Furthermore, semiconductor nanostructures have drawn considerable attention due to their wide ranging applications in optoelectronics, biotechnology and so on. Among these semiconductors, CdS, one of the best direct band gap semiconductors of II–VI group, has drawn intense interest due to their wide applications in solar cell, light-emitting diodes for flat panel display and photocatalyst for chemical reaction [8–11]. Over the last decade, various routes have been developed to synthesize 1D CdS nanostructures including template-assisted synthesis [12], laser ablation [13], photochemical method [14], solvothermal methods [7,11,15], etc. Out of those methods, solvothermal method is an effective and easiest way to synthesize CdS nanorods. In recent years, various surfactants or polymers have been used to synthesize uniform CdS nanostructures [6,16–19]. Lately, the surface modification of fluorescent semiconductor nanostructures by biopolymer has added a new dimension to nanoparticles research with respect to their biological applications [20]. Starch molecules which contains anhydrous glucose unit (AGU) may play a role for the structural modification of composite nanomaterials [21–23].

The purpose of the present work is to study the optical properties of starch capped CdS nanorods as a function of the size by using XRD, SEM, UV–visible and photoluminescence spectroscopy and FTIR spectroscopy.

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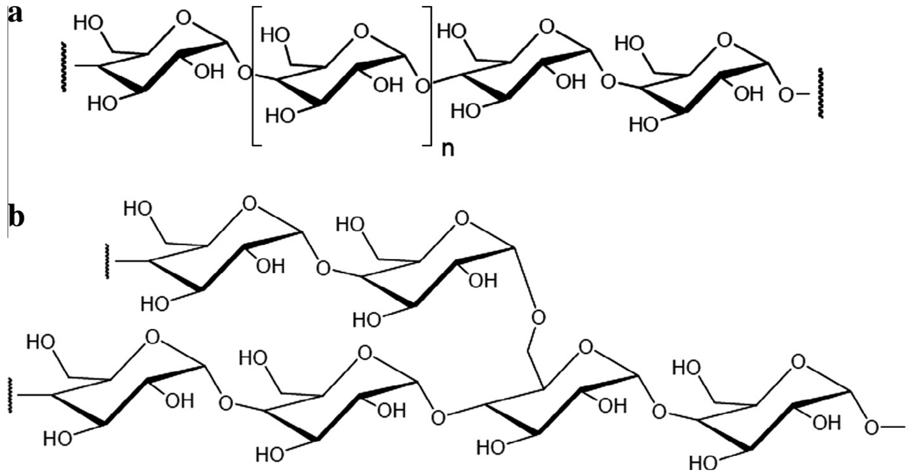

Fig. 1. (a) Chemical structure of amylose and (b) amylopectin of maize starch.

Experimental section

Synthesis

All the chemicals were of analytical grade and were used without further purification. Different types of nano-structured cadmium sulfide (CdS) were prepared by using solvothermal method. Cadmium acetate [$Cd(CH_3COO)_2 \cdot 2H_2O$] and sulfur powder (S) were used as reactant and maize starch was used as the capping reagent. 0.65 g of cadmium acetate and 0.1 g of sulfur powder were dissolved into 40 ml of ethylenediamine (EDA) under vigorous magnetic stirring for 20 min and after that maize starch was mixed using magnetic stirrer for another 10 min. The obtained yellow solution was transferred into a 50 ml Teflon-lined stainless steel autoclave and the autoclave was kept at 150 °C for 2 h. Then the obtained samples were cooled naturally to the room temperature.

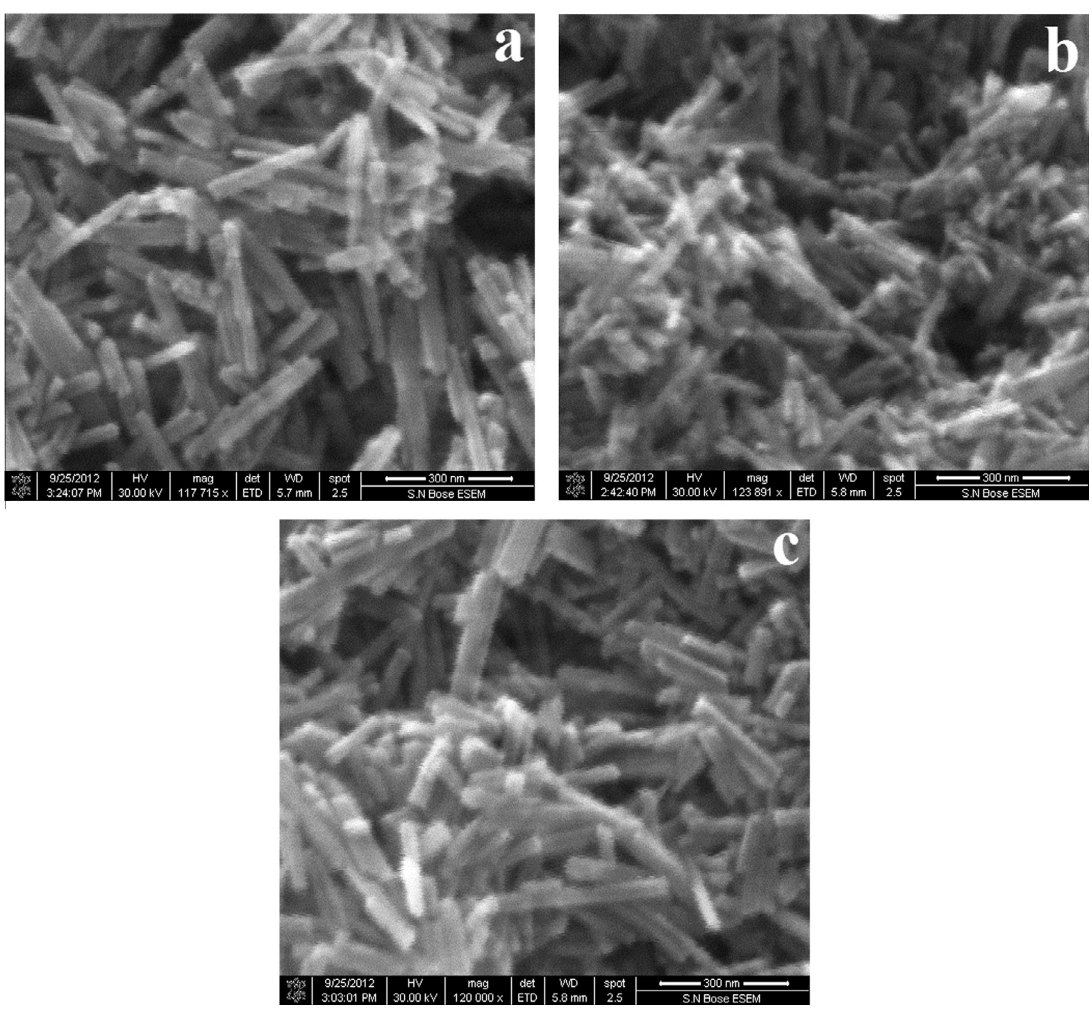

Fig. 2. (a) SEM image of pure CdS nanorods, (b) 50 mg starch assisted synthesized CdS and (c) 100 mg starch assisted synthesized CdS nanorods.