Karlsruhe Institute of Technology

COMPARATIVE STUDY OF CADMIUM SULFIDE NANOPARTICLES SYNTHESIZED BY A CHEMICAL AND BIOTECHNOLOGICAL APPROACH

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Fig. 1 Size-dependent photoluminescent properties of semiconductor cadmium Q dots [1]

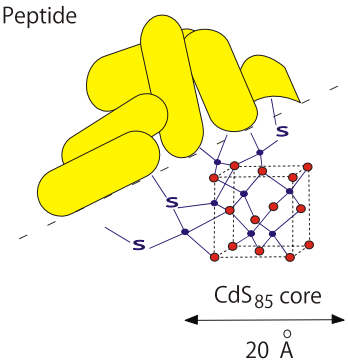

Fig. 2 Model of peptide coated CdS nanoparticles produced by yeasts [2]

INTRODUCTION

Cadmium sulfide (CdS) nanoparticles exhibit unique optical properties and have perfect semiconductor characteristics (figure 1).

This new class of materials, also known as quantum dots (Q dots), revolutionize computer sciences, information technologies and the concept of biological detection and cell imaging.

An alternative to the established and acknowledged chemical procedures is the microbiological nanoparticle synthesis (figure 2). It exploits the potential of living cells to produce highly organized, monodisperse and stable spatial structures.

As nanoparticle properties are expected to be synthesis-related the aim of the present scientific work was to demonstrate the influence of different synthetic pathways on particles' characteristics.

MATERIALS AND METHODS

Experiments were conducted with three different types of CdS nanoparticles:

- Lumidot™ CdS 460, Sigma-Aldrich®
- Chemically synthesized and stabilized with glutathione (GSH) [3]
- Biotechnologically produced (bionanoparticles) by yeast strain of *Schizosaccharomyces pombe* [4]

Nanoparticles were characterized by means of fluorescence analysis, Transmission Electron Microscopy (TEM), Laser Induced Breakdown Detection (LIBD) and Environmental Scanning Electron Microscopy (ESEM).

RESULTS AND DISCUSSION

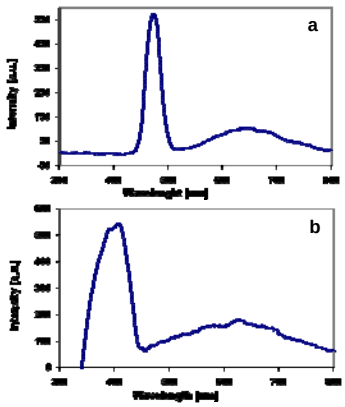

Fig. 3 Emission spectra of CdS nanoparticles excited at UV/VIS
a) Lumidot™ 460, Sigma-Aldrich® b) bionanoparticles

Fluorescence experiments revealed emission maximums of 474 nm for Lumidot™ and 400 nm for bionanoparticles respectively (figure 3). These emissions together with full width at half-maximum (FWHM) 30 nm and 60 nm are characteristic for CdS Q dots. The emission shift towards lower wavelengths observed for the bionanoparticles suggests smaller particle diameter.

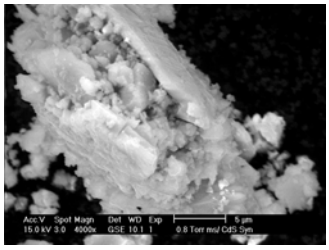

Fig. 4 ESEM image of CdS-GSH crystals

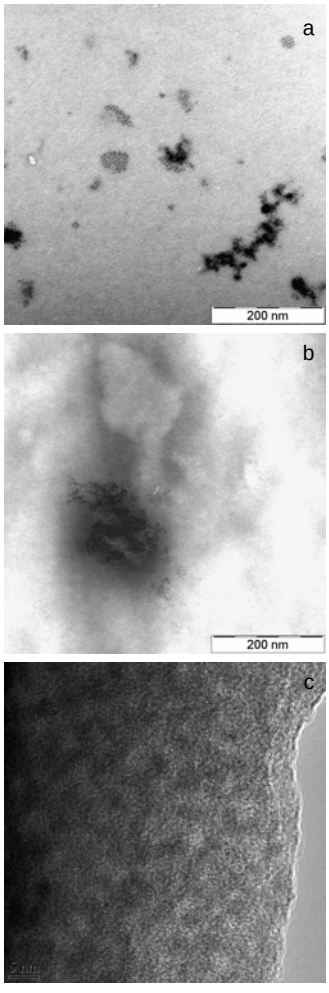

Fig. 5 TEM analysis of CdS nanoparticles:
a) Lumidot™ 460, Sigma-Aldrich®
b) bionanoparticles
c) GSH stabilized particles

The lack of fluorescence from the CdS-GSH product is caused by the formation of crystalline structures confirmed by ESEM analyses (figure 4).

TEM experiments successfully demonstrated the monodispersity of Lumidot™ (fig. 5 a) and bionanoparticles (fig. 5 b). Biotechnologically synthesized nanoparticles have the advantages of the commercially available ones, diameter of 4 nm and in addition are naturally stabilized by a peptide layer. TEM images of CdS-GSH products (fig. 5 c) revealed again only crystalline structures.

Particle size distribution analysis of Lumidot™ and bionanoparticles performed by means of LIBD, showed no evidence of single nanoparticles. The average determined particle size is supposed to be due to agglomerates.

CONCLUSIONS

The comparison between the different products revealed that CdS nanoparticles derived in a biotechnological approach have advantages such as narrow size distribution, stability, water-soluble peptide layer, technologically simple, reproducible and environmentally clean synthesis. This classifies them as desired object for further experiments and practical applications.

ACKNOWLEDGEMENT

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LITERATURE

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