Zinc sulfur-based quantum dots: synthesis and characterization by HRTEM

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Abstract

Nanostructures are materials characterized by their nanoscale size and dimensions between 1 to 100 nm. These materials have distinct properties such as optical, magnetic, and electrical which define their application in technology, industry, and medicine. Moreover, nanostructures are found in daily or household products including cosmetics, clothing, electronic devices, and even in medical procedures. Due to their broad applications, researchers are focused to synthesize these nanostructures in a cost effective an environment friendly manner. Zinc-based nanomaterials have been used in diagnosis of plant diseases, photocatalytic degradation of pharmaceuticals, and dye waste removal. This research is focused on the synthesis and characterization of ZnS quantum dots using High-Resolution Transmission Electron Spectroscopy which allows to nanoparticles characterization. The main research goals of this project are: 1) to synthesize ZnS quantum dots of different nanometric sizes, 2) to stabilize quantum dots in water with thioglycolic acid, and 3) to characterize quantum dots using High-Resolution Transmission Electron Microscopy, Electron Dispersion X-ray analysis, Fluorescence Spectroscopy, Absorbance Spectroscopy, and Infrared.

Introduction

- Nanomaterials have sizes between 1 to 100 nm.
- Quantum dots' fluorescence occurs when its dimensions are 1 to 10 nm.
- The Band Gap of a semiconductor affects the optical properties of the material.

Methodology

H_2O Deionized + $TGA_{(ac)}$

↓

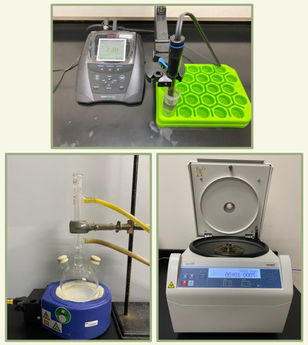
Adjust pH (11.5<) + $ZnSO_{4(ac)}$ + $MnSO_{4(ac)}$

↓

Adjust pH (6.9-7.1)

↓

$ZnSO_{4(ac)}$ + $N_2S_{(ac)}$



Results and Discussion

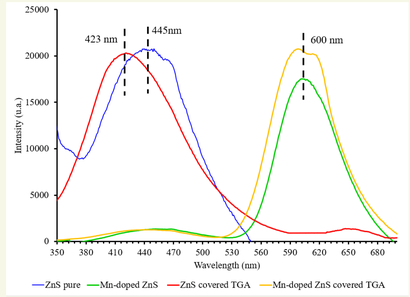


Figure 1: Fluorescence spectra ZnS, ZnS doped Mn, ZnS covered in TGA, and ZnS doped Mn covered in TGA

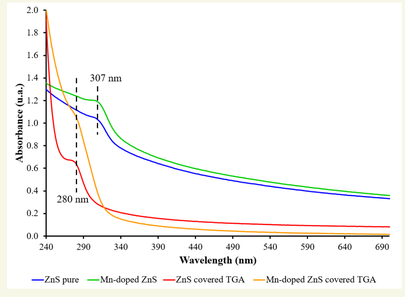


Figure 2: Absorbance spectra of ZnS, ZnS doped Mn, ZnS covered in TGA, and ZnS doped Mn covered in TGA

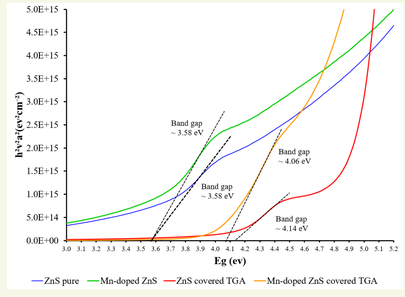


Figure 3: Band Gap of ZnS, ZnS doped Mn, ZnS covered in TGA, and ZnS doped Mn covered in TGA

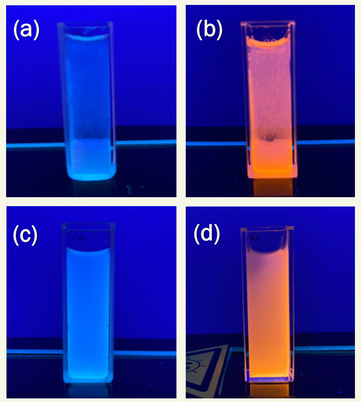


Figure 4: Synthesis of **(a)** ZnS, **(b)** ZnS doped Mn, **(c)** ZnS covered in TGA, and **(d)** ZnS doped Mn covered in TGA

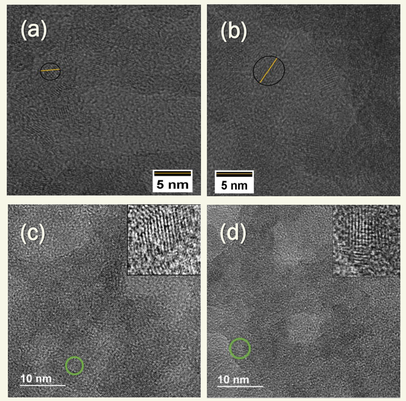
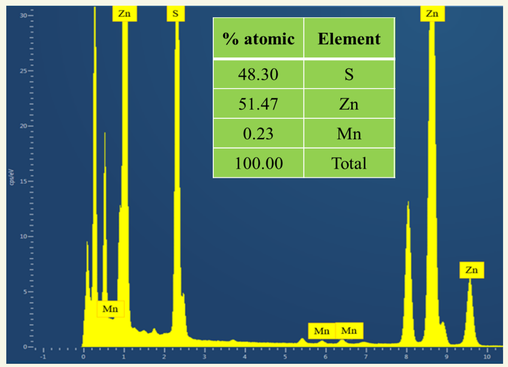


Figure 5: High-Resolution Transmission Electron Microscopy of **a)** ZnS, **(b)** ZnS doped Mn, **(c)** ZnS covered in TGA, and **(d)** ZnS doped Mn covered in TGA



% atomic	Element
48.30	S
51.47	Zn
0.23	Mn
100.00	Total

Figure 6: Energy Dispersion X-ray Analysis of **a)** ZnS, **(b)** ZnS doped Mn, **(c)** ZnS covered in TGA, and **(d)** ZnS doped Mn covered in TGA

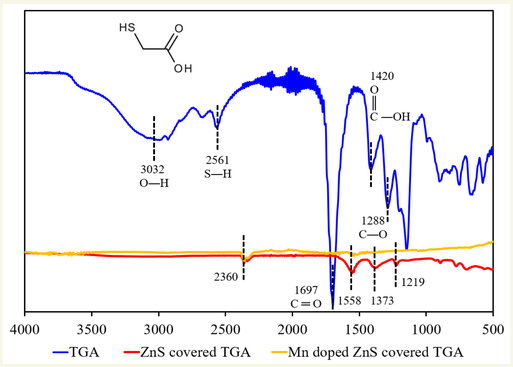


Figure 7: Infrared spectra of thioglycolic acid, **(c)** ZnS covered in TGA, and **(d)** ZnS doped Mn covered in TGA

Conclusion

- Successful synthesis of stabilized and unstabilized in water Zinc-based nanomaterial using thioglycolic acid.
- Zinc blende spherical morphology, composed of S, Zn, and Mn, and have a face centered cubic crystalline structure.

Ongoing Research

- Employ different nanoparticle exposition mechanisms to the seeds.
- Conducts independent germination percentages with the salts of each nanoparticle.
- Assess the quantity of metals contained in the translocation of seedlings.

Acknowledgments

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