Emerging Trends in Plasmonic Nanomaterials: Exploring the Versatility of Lanthanide Doped Cd2SnO4

Lennies P. Kamau, Raul Ortega, Dr. Geoffrey F. Strouse
Department of Chemistry & Biochemistry, Florida State University, Tallahassee, FL

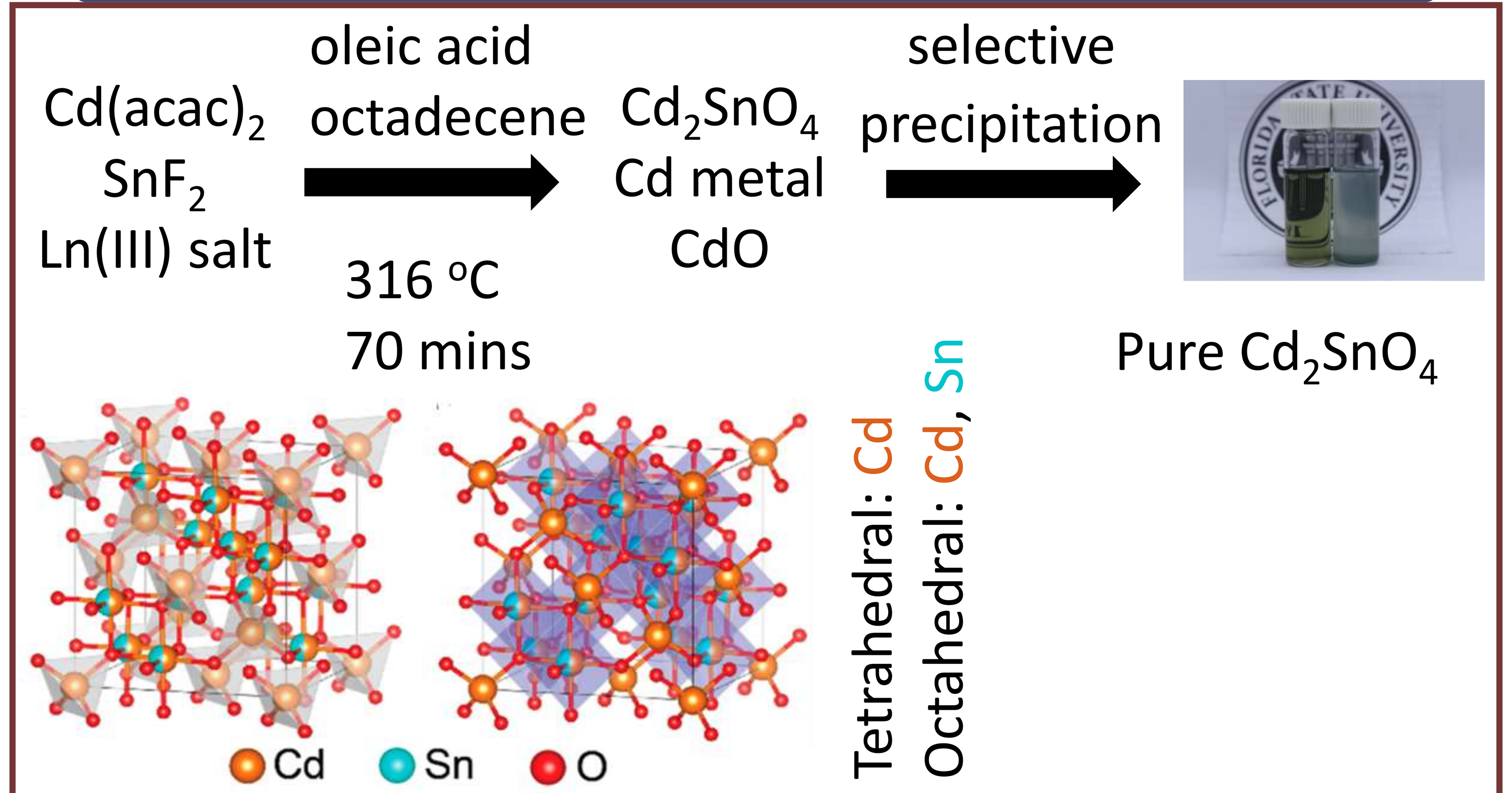
Background

- Nanomaterials, particularly plasmonic nanomaterials, have become a cornerstone of chemistry research over the past three decades.
- Plasmonic nanomaterials, such as plasmonic metal oxide nanoparticles, offer versatile applications in photothermal therapy, electrochromic windows, and enhanced radiation absorption.
- Plasmonic metal oxide nanoparticles exhibit distinctive plasmon absorption features due to the oscillation of "Free" carriers at their surface, spanning from the visible to the infrared spectrum.
- There's a growing trend favoring plasmonic semiconductor nanocrystals (PSNCs) over conventional expensive metal nanoparticles like gold and silver, with Cd2SnO4 emerging as a promising PSNC due to its ability to dope with various functional atoms while maintaining its plasmonic characteristics.

Purpose

• The purpose of this research proposal is to investigate and develop novel plasmonic semiconductor nanocrystals (PSNCs) with enhanced properties for various technological applications, specifically ones that are doped with lanthanides.

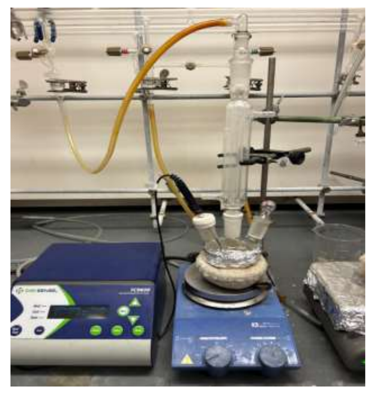
General Schematic of Plasmons



Spinel Structure for Cd_2SnO_4

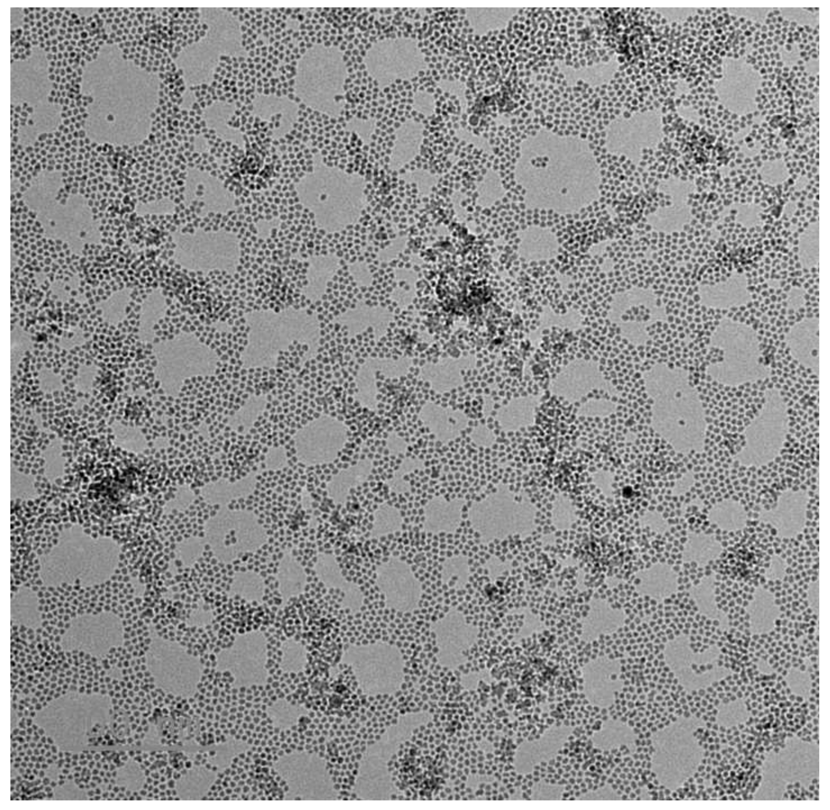
Nanoparticle Synthesis

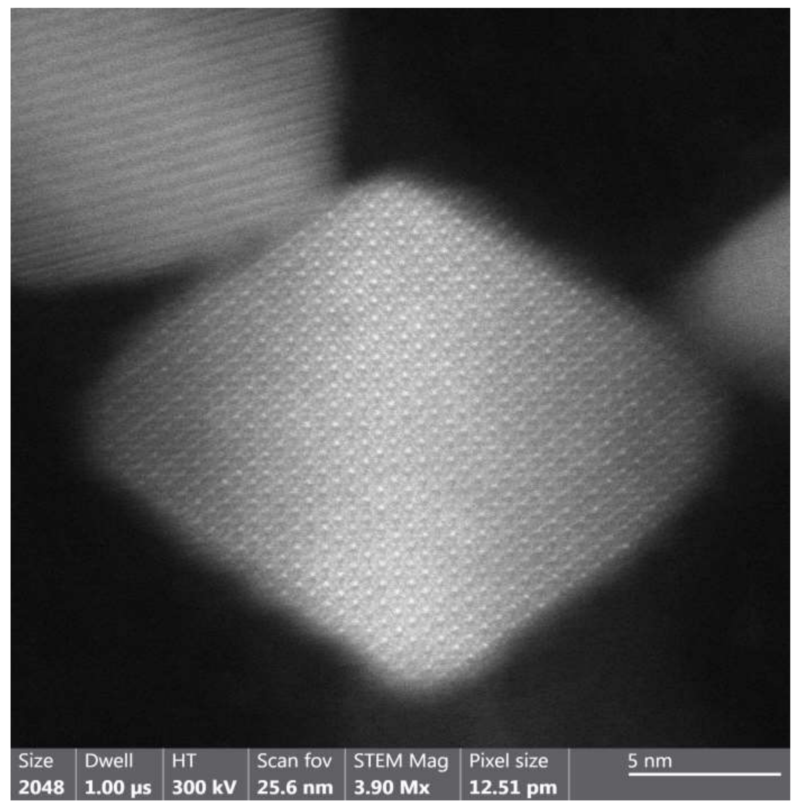
- Weigh out 373 mg of Cadmium acetylacetonate (Cdacac) and 47 mg of Tin (II) fluoride (SnF2), transferring each onto separate weighing papers.
- Transfer the weighed amounts of Cdacac and SnF2 into a clean 3-neck round bottom flask.
- Add 25 mL of Octadecene and 2.4 mL of Oleic acid to the round bottom flask. The Oleic acid acts as the ligand. Place a stir bar into the solution and connect the middle opening of the round bottom flask to the Schlenk line burette using holding clips.
- Set the temperature controller to 120 degrees Celsius for degassing. Open the valve on the vacuum manifold connected to the Schlenk line tube to initiate degassing. Cover the flask with aluminum foil to retain heat and let it degas for 45 minutes.
- After degassing, set the temperature controller to 320 degrees Celsius and the power level to 100%. Reflux the solution at a temperature close to 319 degrees Celsius.
- Add 2-3 mL of toluene and IPA to the post-nucleation solution in a plastic centrifuge bottle. Centrifuge the mixture at suitable settings, remove the supernatant containing plasmonic product oils, and dissolve/suspend remaining product in a toluene.
- Transfer the supernatant containing dissolved nanocrystals to a clean plastic bottle, repeat flocculation with IPA, centrifuge, and store the precipitated nanocrystals in an appropriate solvent.



Nanoparticle Synthesis Method Images

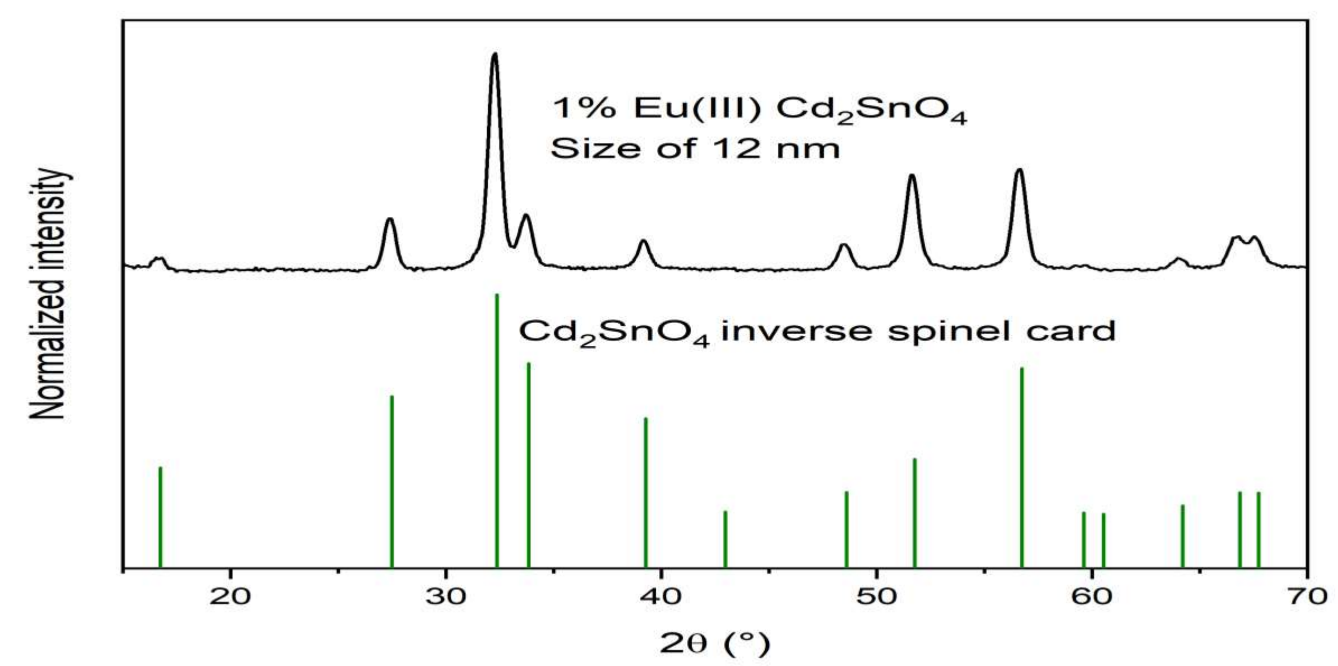
Final Product





TEM images of the Cd_2SnO_4 particles

Results and Conclusions



Intensity vs Normalized Density for Cd2SnO4

- Successful synthesis of Eu(III) doped Cd2SnO4 (CTO) nanocrystals (NCs) with an inverse spinel structure.
- Absence of impurities such as CdO or SnO2 in the powder pattern.
- NC size approximately 12 nm determined by the Halder – Wagner method using Si as an external standard.
- Next steps involve characterizing localized surface plasmon resonance (LSPR) through UV-Vis absorption and determining the amount of Eu(III) ion incorporated into the CTO lattice using X-ray fluorescence (XRF).
- Currently synthesizing a sample with 10% nominal Eu(III) content for further analysis.

Acknowledgments

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References

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