Novel Encapsulation of Cadmium Orthostannate Nanoparticles with 3-(mercaptopropyl)trimethoxysilane : Synthesis, Characterisation, and Application

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1. Introduction

Metal and Metal Oxide Nanoparticles

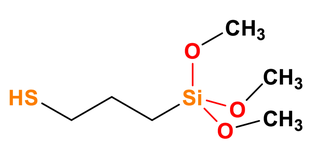
Infrared radiation **reflecting** and **absorbing** ability → **Thermal insulation** for buildings → **Reduced energy** use for passive cooling → **Environmentally-friendly building materials**

Core-shell Structure	Cadmium Orthostannate Nanoparticles (Cd_2SnO_4 NPs)	Aims
Better **dispersion** in water	Promising **IR reflecting** and **absorbing** ability	Prepare silica-coated Cd_2SnO_4 NPs using **MPTMS** as a precursor
Resistance to oxidation	**Low cost**	Characterisation of Cd_2SnO_4@SiO_2 NPs to test their **dispersion** in water and **thermal insulation** abilities
Reduced health hazards posed by toxic metal compounds	Chemical **stability**	

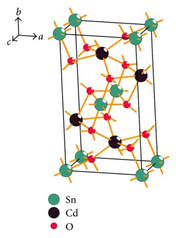
2. Experimental

1. Materials

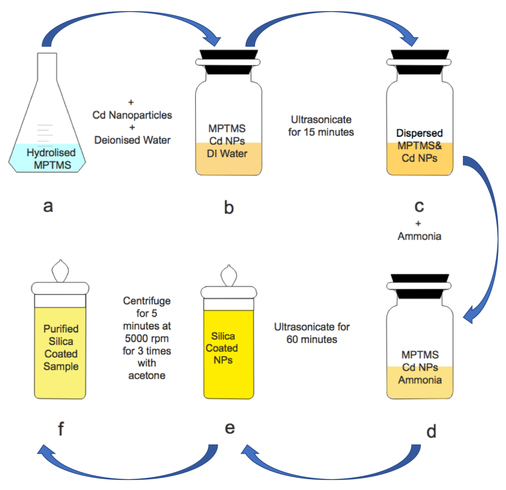
MPTMS



Cd_2SnO_4 NPs



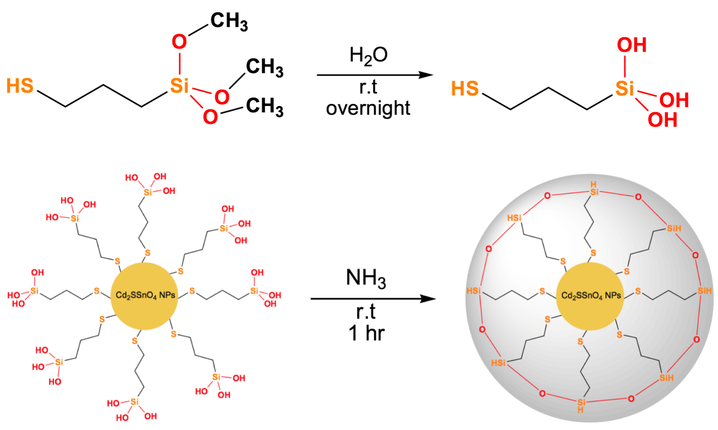
2. Synthesis



3. Characterisation

- Transmission Electron Microscopy (TEM)
- Dispersion Test
- UV-Vis-NIR Optical Transmittance Test
- Temperature Change Test

4. Mechanism



3. Results and Discussions

1. Morphology

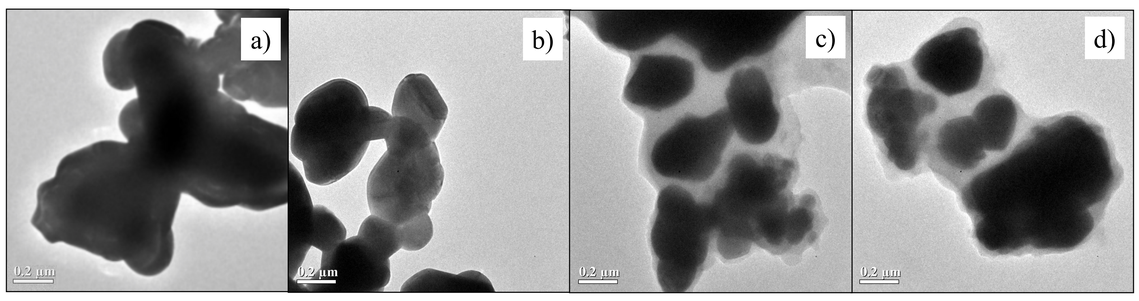


Fig. 1 TEM images of Cd_2SnO_4 NPs **a & b)** before coating and **c & d)** after coating

- a & b): Bare Cd_2SnO_4 NPs (~60 nm)
- c & d): Cd_2SnO_4 NPs uniformly coated with a silica shell with an average thickness of 40 nm

2. Dispersion Test

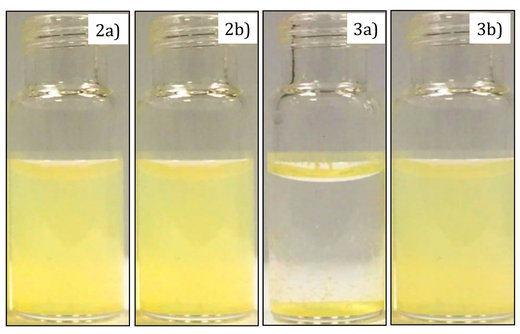


Fig. 2 & 3a) Cd_2SnO_4 NPs water suspension in glass vial at t=0, 60 min; **2 & 3b)** Cd_2SnO_4@SiO_2 NPs water suspension in glass vial at t=0, 60 min.

- **Bare** Cd_2SnO_4 NPs settle at the bottom of the glass vial → **poor dispersion**.
- **Coated** Cd_2SnO_4@SiO_2 NPs remain uniformly dispersed in water → **good dispersion**.

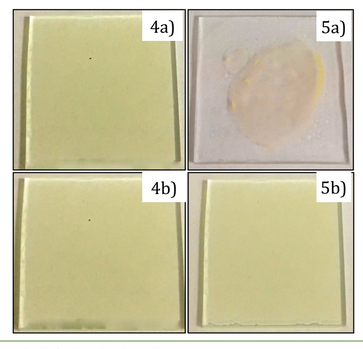


Fig. 4 & 5a) Cd_2SnO_4 NPs water suspension on glass slide at t=0, 60 min; **4 & 5b)** Cd_2SnO_4@SiO_2 NPs water suspension on glass slide at t=0, 60 min.

- **Bare** Cd_2SnO_4 NPs agglomerate in the centre → **poor dispersion**.
- **Coated** Cd_2SnO_4@SiO_2 NPs remain uniformly dispersed in water → **good dispersion**.

3. UV-Vis-NIR Test

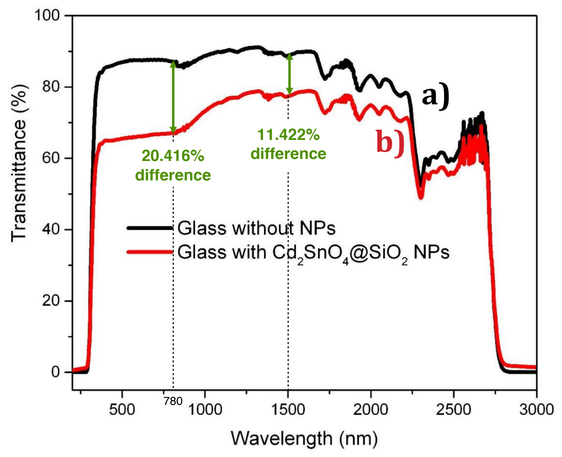


Fig. 5 UV-Vis-NIR Transmittance spectra of glass slides coated with **a)** bare WPU **b)** Cd_2SnO_4@SiO_2 NPs

- Significant **decrease of transmittance in NIR range** observed of glass slide painted with Cd_2SnO_4@SiO_2 NPs → Better **IR radiation shielding** ability.

4. Temperature Change Test

- Temperature **below** glass slide coated with Cd_2SnO_4@SiO_2 NPs **rises slower** compared to both slides coated with bare WPU (Fig. a) and with bare Cd_2SnO_4 NPs (Fig. c)→ Silica coating **reduces thermal transmission through** the glass slides.

- Temperature **of** glass slide coated with Cd_2SnO_4@SiO_2 NPs **rises faster** compared to both slides coated with bare WPU (Fig. b) and with bare Cd_2SnO_4 NPs (Fig. d)→ Silica coating **enhances absorption of heat by** the glass slides.

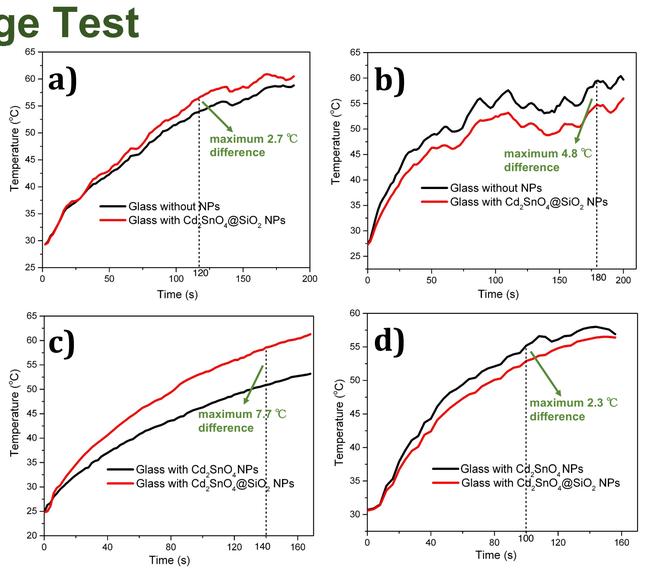


Fig. 6 Temperature changes of **a & c)** glass slides; **b & d)** air below glass slides.

4. Conclusion

Cd_2SnO_4@SiO_2 NPs display

- Enhanced dispersion
- Significant decrease in NIR transmittance
- Higher heat absorption rate & Lower heat transmittance rate

5. Future Work

Investigation of

- Thermal shielding ability of coated NPs on **different substrates**, e.g. plastic, concrete, ceramic.
- **Other properties** of Cd_2SnO_4@SiO_2 NPs, e.g. endurance, strength or self-cleaning ability.

References

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