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CdS Quantum-dots/TiO₂ Nanotube Heterostructure for Efficient Photocatalytic Hydrogen Evolution

Introduction
Photocatalytic H₂ evolution through water splitting is an important approach to fabricate a sustainable and renewable energy source. Currently, the development of photocatalytic water splitting is limited by the low efficiency and poor stability of photocatalysts. Among all the studies of photocatalyst, TiO₂ and CdS are well developed and show excellent performance. This project aims to synthesis the heterostructure of CdS quantum-dots/TiO₂ nanotube, and study the potential application of it in water splitting.

Methods

![Diagram of the experiment procedure]

2. Add the tubes, Cd(CH₃COO)₂ and sulfide precursor.
3. Pre-stir of the mixture.
4. Heat the mixture to high temperature to obtain the heterostructure.
5. qualitative analyses and property tests.

Results
The product was washed and dried in air. The final product with yellow color (Figure. 2 a) is collected. X-ray Diffraction (XRD) measurement was used to monitor the crystal structures of the product. (Figure. 2 b) The result shows that the heterostructure product is consisted of cubic CdS and TiO₂ nanotube.

![Image of product and XRD plot]

SEM image was also taken for the products. (Figure. 3) The images show the morphology which is of desired quantum-dots/nanotube heterostructure:

![SEM images of TiO₂ nanotubes, CdS nanoparticles, and heterostructure with pre-treatment]

The SEM images also show controlled morphology and a good pre-treatment can lead to a much finer dots and more uniform distribution, which makes the performance better.

Photocatalytic performance of the product at visible light region (> 420 nm) was measured. (Figure. 4)

![Graph of H₂ evolution for TiO₂, CdS, and heterostructure]

The result shows that this heterostructure is highly efficient and the nearly straight line also indicates commendable stability under long time work.

Conclusion
The heterostructure of CdS quantum-dots/TiO₂ nanotube has been synthesized successfully and the morphology is well controlled. It shows good efficiency as a photocatalyst in water splitting and great resistance to photocorrosion. In consider of the availability and low cost of the product, it is a suitable photocatalyst in mass production of H₂.