A Study on Photocatalytic Synthesis and Optical Properties to Improve Hydrogen Production Capacity by Dual Z-scheme with Thermal Treatment

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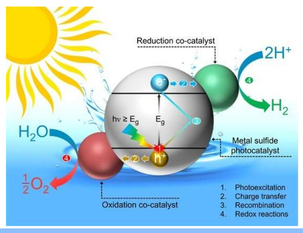
Introduction

◆ Photocatalyst

- Generally, a photocatalyst refers to a catalyst that accelerates chemical reaction using the energy from the light under irradiation of light. The majority of photocatalysts are based on semiconductor materials and they generate electron-hole pairs under irradiation which are utilized to accelerate reactions.



- Recently, the synthesis of highly efficient photocatalyst has been under investigation as one of the environment-friendly methods of producing hydrogen gas(H_2).

Experimental

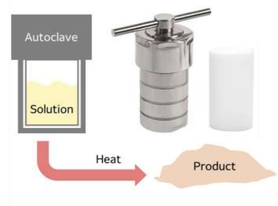
◆ Process

Synthesis of Cds nanorods	
$Cd(NO_3)_2 \cdot 4H_2O$	3.0848g
$CS(NH_2)_2$	2.2836g
Ethylene diamine	60mL

Synthesis of $g-C_3N_5$	
$3-amino-1,2,4-triazole$	3.0848g
KBr solution	15g in 25mL H_2O

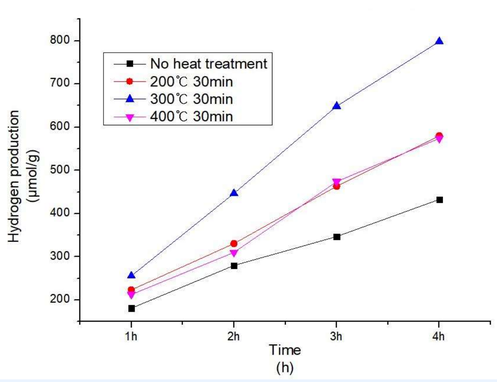
Synthesis of $g-C_3N_5$/CdS (0.5wt%)	
$g-C_3N_5$	0.005g
CdS	0.995g
methanol	50mL

◆ Thermal Treatment

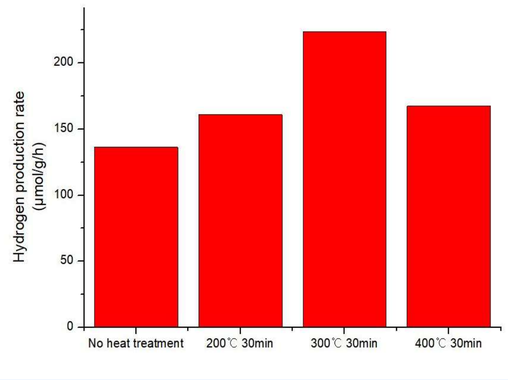


Results & Discussion

◆ Hydrogen production



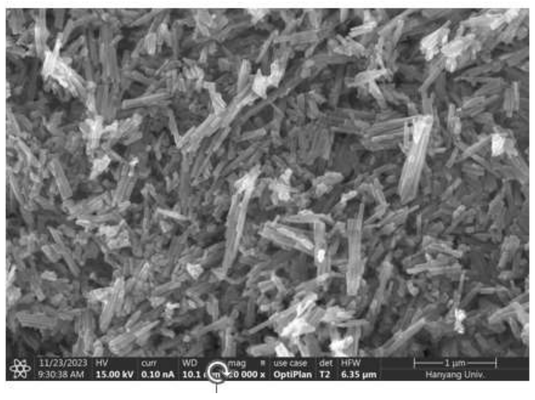
◆ Hydrogen production rate



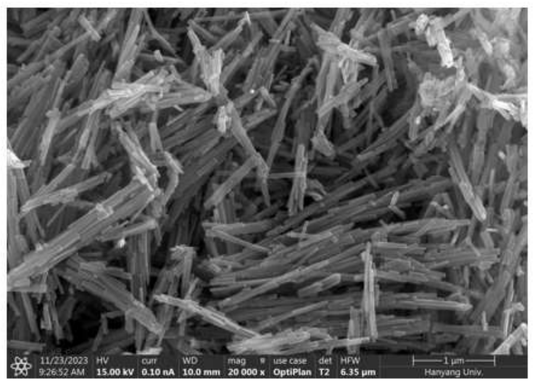
- The overall hydrogen production increased under ***thermal treatment*** compared to non-thermal treatment sample.
- The largest hydrogen production was shown ***under thermal treatment*** at 300°C for 30 minutes.
- ***Under thermal treatment*** at 300°C for 30 minutes the hydrogen production rate is about 250 μmol/g/h, producing the largest amount of hydrogen.

◆ FE-SEM

Without thermal treatment

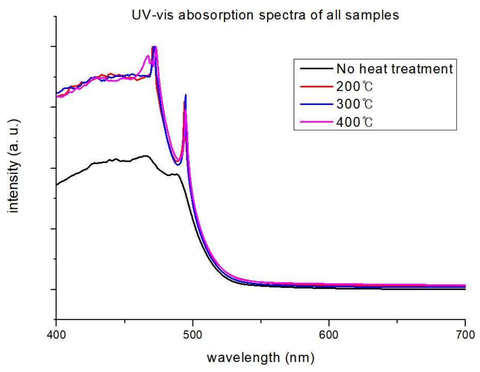


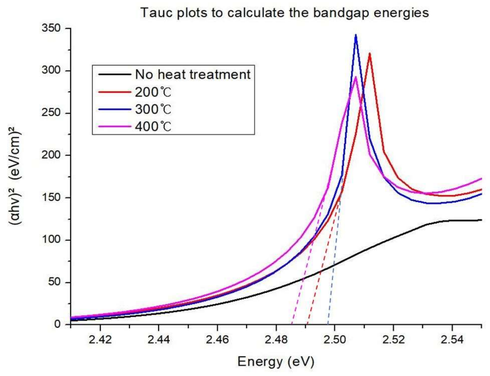
Under thermal treatment



- *Under thermal treatment*, the crystalline structure is rearranged into relatively large size than *non-thermal treatment.* So, we can see large nanorods *under thermal treatment*.
- This change of crystalline structure was caused by particle aggregation and affected the performance of photocatalyst. All *Under thermal treatment* samples showed higher performance than *without thermal treatment* sample.

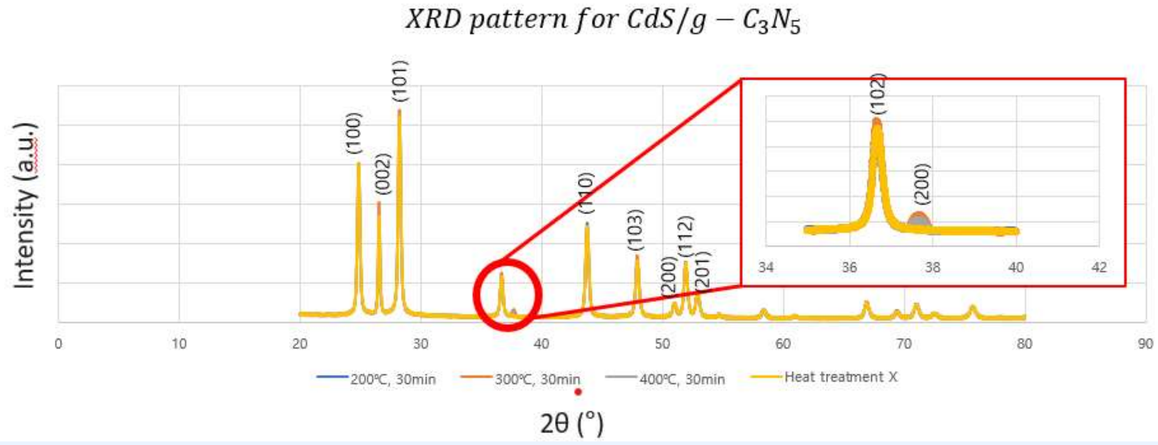
◆ Absorption spectra and Tauc plot





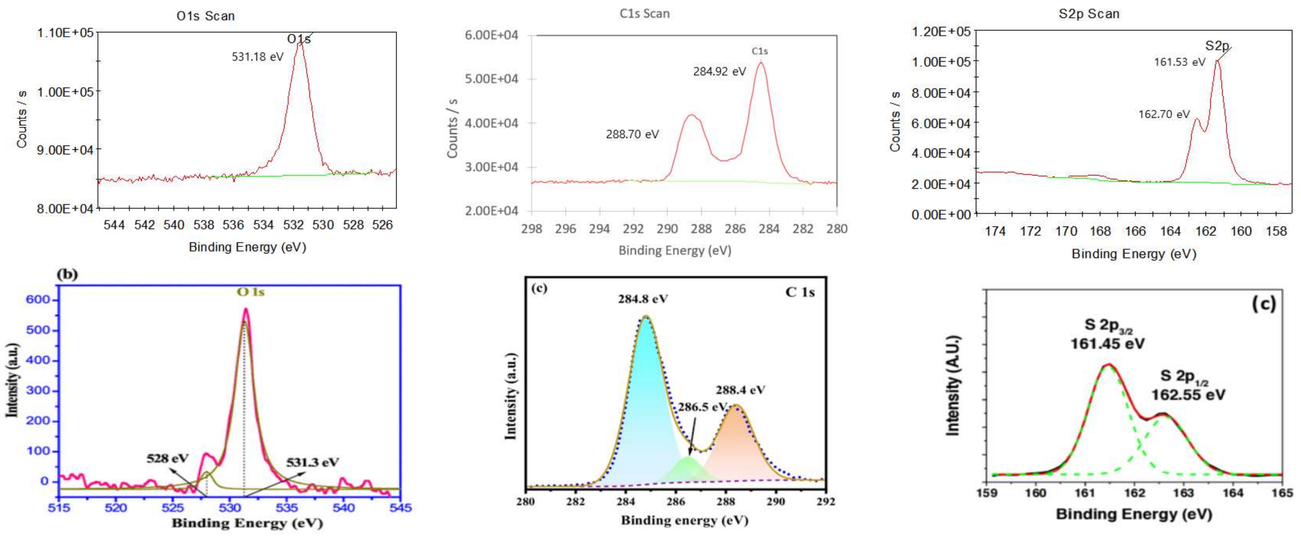
- *Thermal treatment* samples show improved absorption spectrum in visible light regions which means enhancement of absorbance
- *Thermal treatment* samples show larger bandgap than the *non-thermal treatment* sample.

◆ XRD pattern



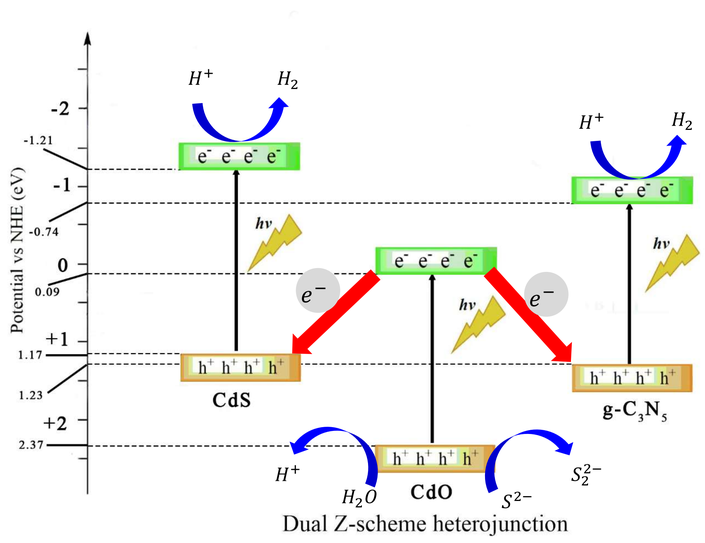
- A faint peak CdO peak was observed near 27° after ***thermal treatment***.
- This indicates that the ***thermal treatment*** led to the oxidation of CdS to CdO.

◆ XPS spectra



- Considering the XPS peak shift, it is expected that CdS and g-C3N5 receive electrons and CdO gives electrons.

◆ Band Diagram



Conclusions

- The $g-C_3N_n/CdS$ composite was subjected to thermal treatment at various temperatures for 30 minutes, and hydrogen production was analyzed using gas chromatography. As a result the highest production was at 300℃.
- XRD was employed to confirm the presence of CdO peaks.
- Band gap and the direction of electron movement were investigated using UV-visible spectroscopy and XPS, respectively.

Reference

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