# Effect of Copper Doping on the Hydrogen Production of NiZnS Photocatalyst

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## Abstarct

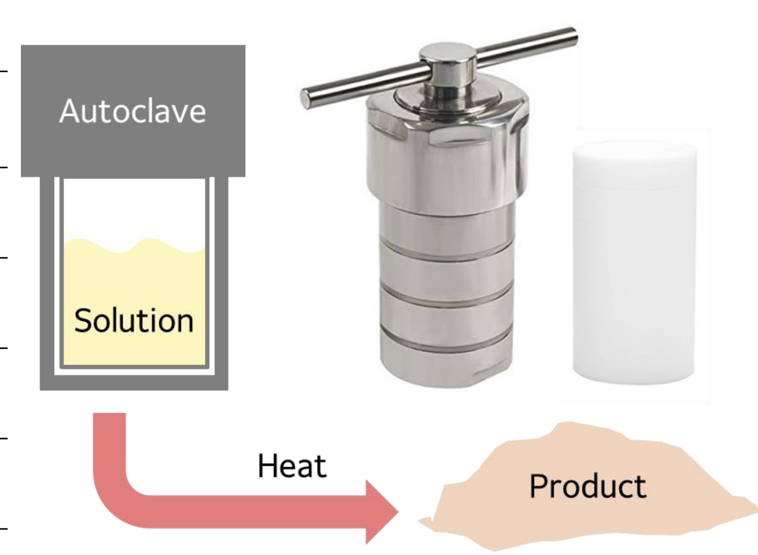
Recently, solar energy is attracting attention as an eco-friendly energy source for the future. In order to enhance hydrogen production efficiency, NiZnS heterostructure photocatalysts are investigated for solar water splitting in this study. In photocatalysts, heterostructures with a ZnS component are widely used due to its high stability. As a co-catalyst, nickel is added to ZnS to improve hydrogen evolution efficiency. In addition, hydrogen productivity is also examined by doping copper precursor. The copper doping improves absorbance of photocatalyst in visible region and helps lower the energy of conduction band. Also, copper is cheaper than other metals. The NiZnS photocatalyst was prepared by a hydrothermal method, the copper doping was proceeded at 8.5 wt% and 10 wt% and is also prepared hydrothermal method. Hydrogen production performance is evaluated by applying the gas chromatography. The highest hydrogen production was resulted 8.5 wt% Cu-NiZnS photocatalyst because it has low band gap.

## Experimental

### Ⅰ. NiZnS Synthesis

Hydrothermal method, 200℃, 24 h

| Materials | Formulation |
|---|---|
| Zinc nitrate hexahydrate | 4.6172 g |
| Nickel nitrate hexahydrate | 0.1396 g |
| Thiourea | 2.4358 g |
| Distilled water | 160 mL |




### Ⅱ. Cu doped on NiZnS

Hydrothermal method, 160℃, 8 h

| Materials | 6.5 wt% Cu | 8.5 wt% Cu | 10.5 wt% Cu |
|---|---|---|---|
| NiZnS photocatalyst | 0.4695 g | 0.4608 g | 0.4525 g |
| Copper nitrate trihydrate | 0.0305 g | 0.0392 g | 0.0475 g |
| Distilled water | 80 mL | | |

## Conclusion

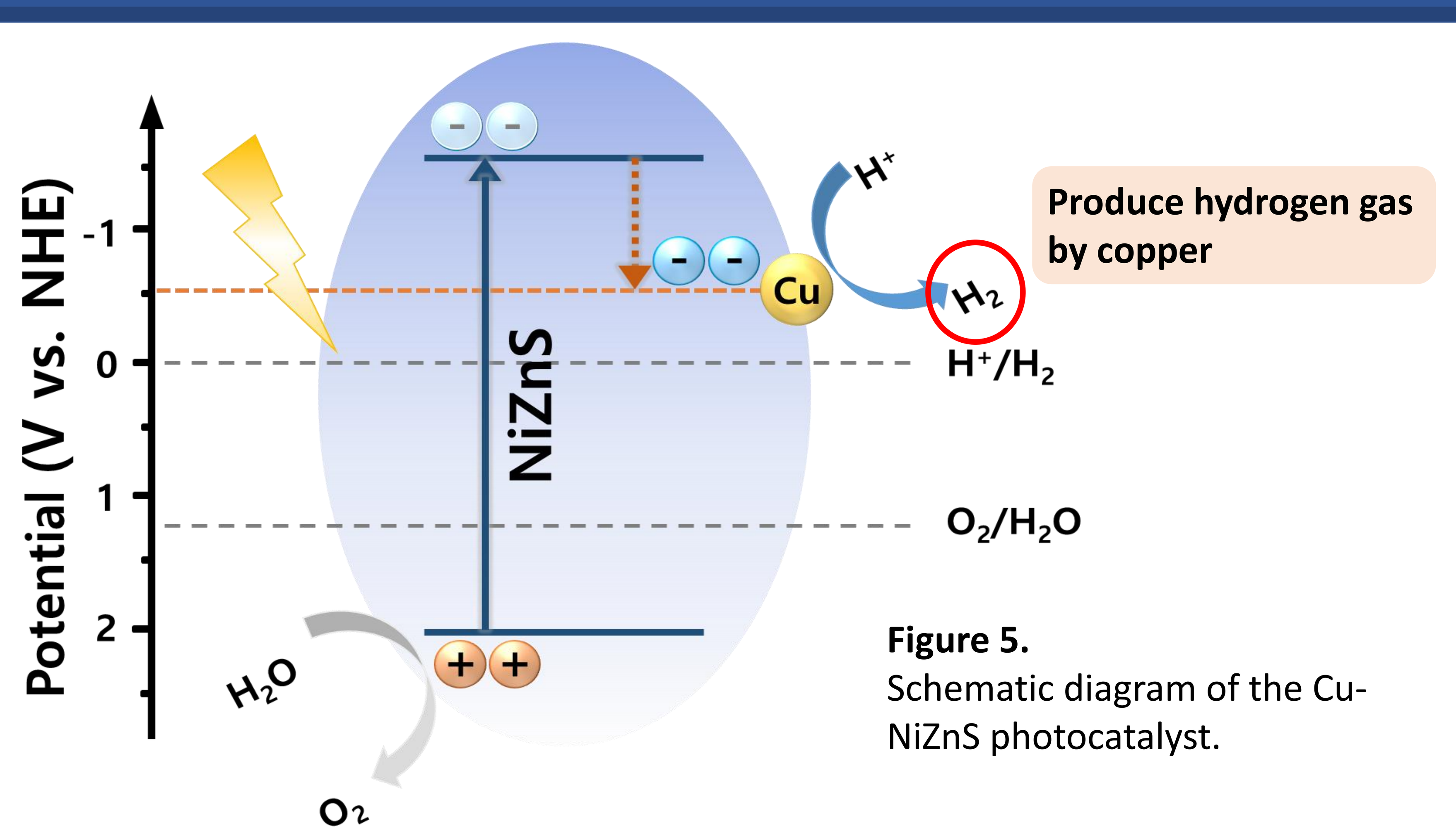



**Figure 5.** Schematic diagram of the Cu-NiZnS photocatalyst.

1) NiZnS photocatalyst and Cu-NiZnS photocatalyst was synthesized hydrothermal method.
2) 8.5 wt% Cu-NiZnS photocatalyst showed the highest hydrogen production because the high absorbance in visible region with the narrowest band gap.
3) Reproducibility of the 8.5 wt% Cu-NiZnS photocatalyst reveals stable operation mechanism.
4) The larger the copper contents, the larger the particle size.
5) Through XPS analysis, the binding form of the Cu-NiZnS particles.
6) It is estimated that the band gap was narrowed by reducing the energy of the NiZnS conduction band with copper doping.

## Result & Discussion

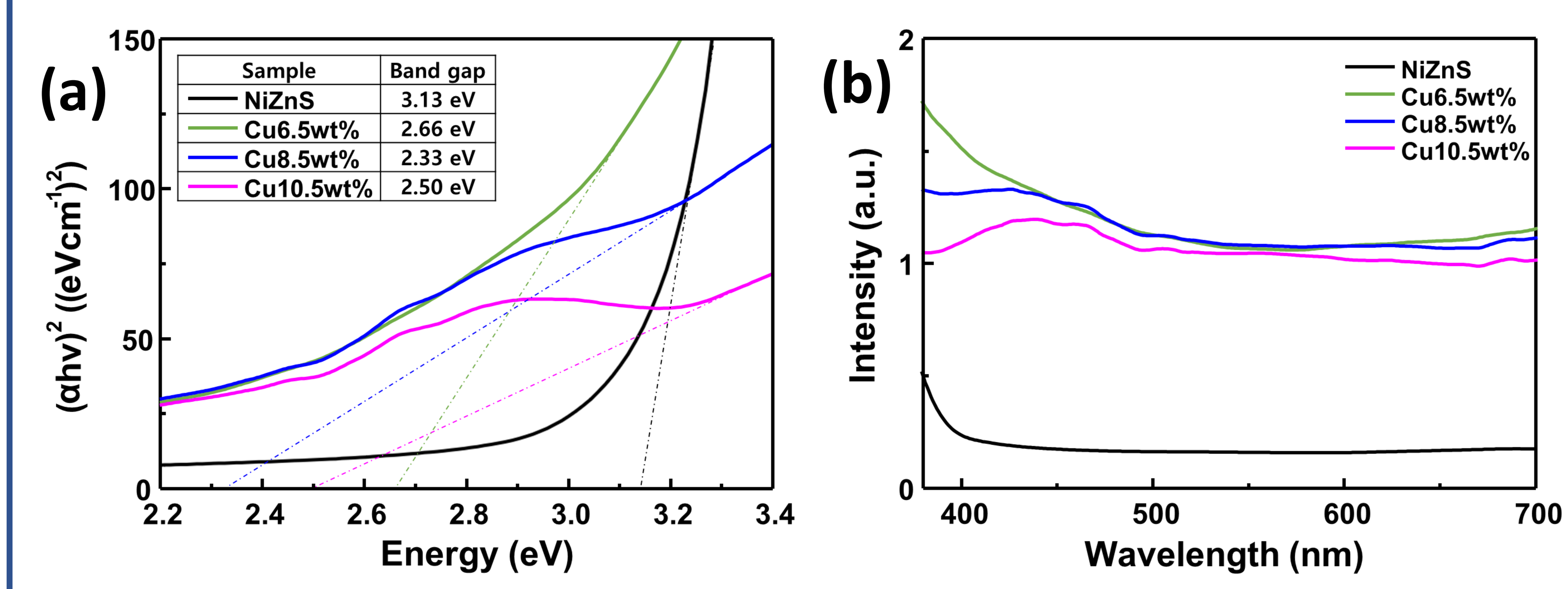



**Figure 1.** (a) Tauc plots to calculate band gaps of NiZnS and Cu-NiZnS photocatlaysts, (b) UV-vis absorbance spectra from the NiZnS and Cu-NiZnS photocatalysts.

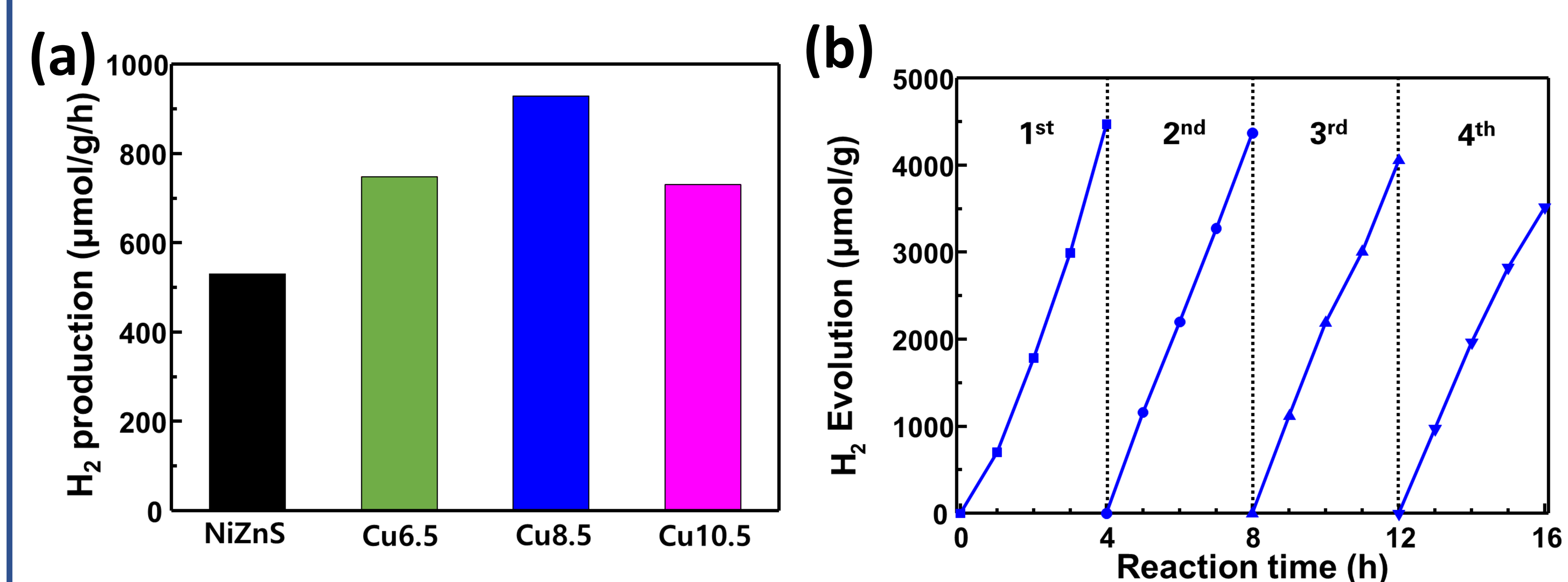
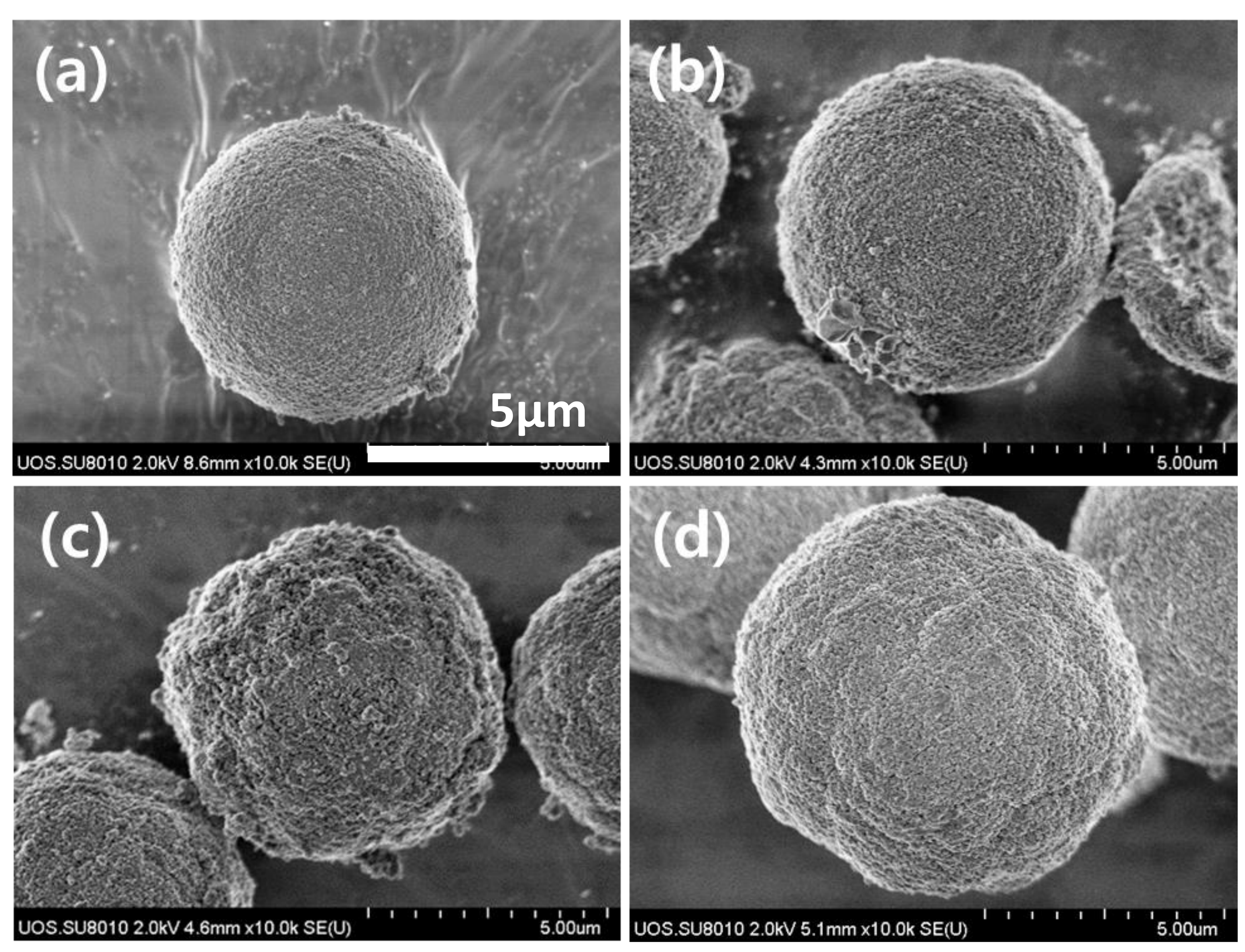
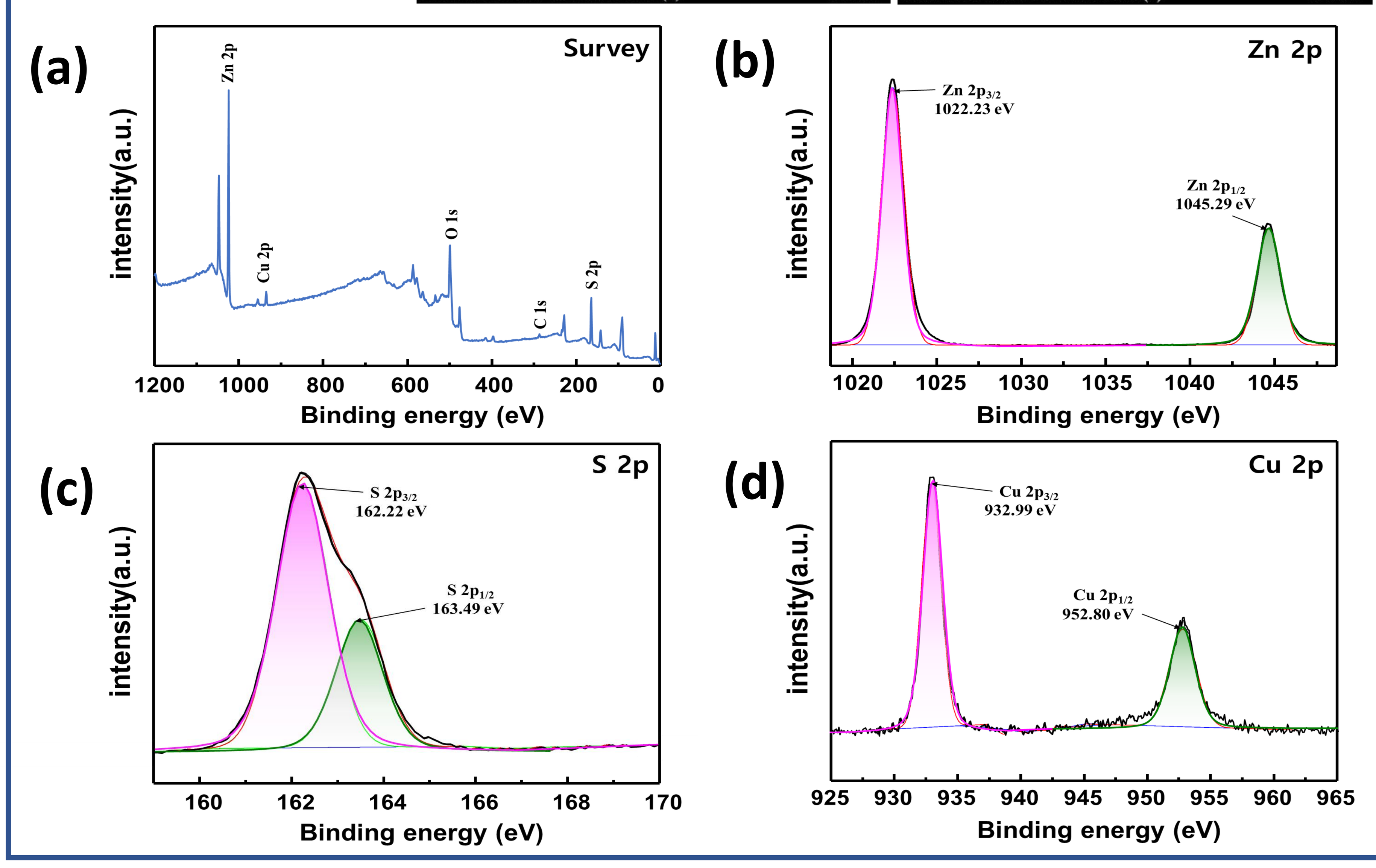



**Figure 2.** (a) $H_2$ productions from NiZnS photocatalyst and Cu-NiZnS photocatalysts of various Cu:NiZnS ratios, (b) Reproducibility of $H_2$ evolutions at 8.5 wt% Cu-NiZnS photocatalyst

▶**Figure 3.** SEM images from the NiZnS (a), Cu-NiZnS photocatalyst 6.5 wt% (b), 8.5 wt% (c), 10.5 wt% (d).




▼**Figure 4.** XPS spectra of (a) Survey, (b) Zn 2p, (c) S 2p, (d) Cu 2p from the 8.5 wt% Cu-NiZnS photocatalyst.

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