

Effects of composition of $\text{Cu}_2\text{Sn}_x\text{Ge}_{1-x}\text{S}_3$ particles on photocatalytic and photoelectrochemical hydrogen evolution activity

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Photocatalytic and photoelectrochemical (PEC) water splitting has been regarded as a potential means of solar energy harvesting in the form of hydrogen. Recently, $\text{Cu}_2\text{Sn}_x\text{Ge}_{1-x}\text{S}_3$ (CTGS) polycrystalline thin films have attracted significant attention as light-absorbing materials responsive up to near-infrared (IR) light with applications to efficient solid-state solar cells.¹ CTGS shows tunable band gap energies according to the Sn/Ge ratio. The chemical stability and lack of toxicity of CTGS are also advantageous points compared with the other photovoltaic materials such as $\text{Cu}(\text{In,Ga})\text{Se}_2$ and CdTe . However, photocatalytic or PEC water reduction at the surface of CTGS have been rarely reported to date. In the present study, we demonstrated the photocatalytic and PEC hydrogen evolution using CTGS particles for the first time.

The current-potential curves for the particulate CTGS photocathodes with various Sn/Ge ratio prepared by the particle transfer method² are presented in Figure 1. The cathodic photocurrent at negative potential gradually enhanced according to the increased Sn contents and reached approximately 5 mA cm^{-2} at 0 V_{RHE} for $\text{Sn}/(\text{Sn}+\text{Ge}) = 0.62$. Meanwhile, the relatively Ge-rich specimens ($\text{Sn}/(\text{Sn}+\text{Ge}) = 0$ and 0.38) showed relatively high photocurrent at positive potential around the onset potential. The positive shift of the conduction band according to the increased Sn contents, as well as the Cu-deficient secondary phase, can affect the PEC performances. In the presentation, the photocatalytic hydrogen evolution and the effect of the Cu-deficiency will be also discussed.

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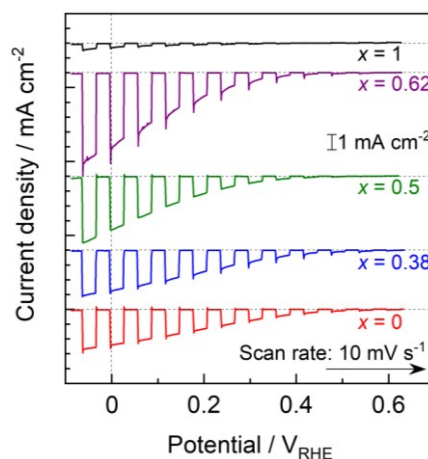


Figure 1. Current-potential curves for the particulate CTGS photocathodes in 1 M potassium phosphate buffer electrolyte (pH = 7) under simulated sunlight.