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Titanium dioxide-coated copper electrodes for hydrogen production by water splitting

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HIGHLIGHTS

- Development of TiO_2–C/Cu electrode for hydrogen production by UV irradiation.
- Cu corrosion was prohibited due to TiO_2 layer.
- Enhancement of hydrogen production by TiO_2–C/Cu electrode.
- Decomposition of formaldehyde in artificial wastewater by TiO_2–C/Cu electrode.

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ABSTRACT

Pt is the most commonly used electrode and catalyst materials for H_2 production via water splitting as it provides the highest Gibbs free energy of H_2 adsorption (ΔG_H) an d overpotential. However, as Pt catalysts are expensive and difficult to mass-produce, several efforts have been made to identify suitable substitutes. Although Cu provides lower ΔG_H and overpotential than Pt, it exhibits better catalytic performance than other catalysts and is suitable for H_2 production. However, corrosion of Cu may affect its stability of Cu electrode. To overcome this limitation, we have coated a layer of carbon on the copper electrode and then synthesized titanium dioxide-(TiO_2-) on the C/Cu electrode for water splitting application. Carbon black (CB) has excellent electrical conductivity and stable resistance for effective working as an electrochemical catalyst, and TiO_2 has diverse applications because of its low-cost, non-toxic, and corrosion-resistant characteristics. In this study, TiO_2 was synthesized on C/Cu electrodes under UV irradiation for different durations. The optimum irradiation duration was determined to be 15 min via surface and electrochemical analyses. To identify the potential applications of this TiO_2–C/Cu electrode, we used artificial wastewater as the electrolyte. The synthesized TiO_2–C/Cu electrode exhibited better stability than C/Cu electrode. Further, H_2 production with TiO_2–C/Cu electrode was higher than that with C/Cu electrode at the same current density. We also investigated the effect of TiO_2–C/Cu electrode on decomposition of formaldehyde.

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