Supporting Information

Triple Layered Ga₂O₃/Cu₂O/Au Photoanodes with Enhanced Photoactivity and Stability by Iron Nickel Oxide Catalysts

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Figure S1. Measured light transmittance of ITO/Al₂O₃.

Table S1. Electric properties of Cu₂O. (n- carrier concentration, ρ- resistivity, μ - mobility)

n (cm ⁻³)	ρ (Ω cm)	μ (cm² V ⁻¹ s ⁻¹)	Туре	
1.90 ×10 ¹⁷	97.0	10.7	р	
8.88 ×10 ¹⁶	97.5	22.8	р	
8.22 ×10 ¹⁸	88.9	24.7	р	
1.25 ×10 ¹⁸	86.4	16.2	р	
6.34 ×10 ¹⁷	97.6	31.9	р	
	n (cm ⁻³) 1.90×10^{17} 8.88×10^{16} 8.22×10^{18} 1.25×10^{18} 6.34×10^{17}	n (cm ⁻³)ρ (Ω cm) 1.90×10^{17} 97.0 8.88×10^{16} 97.5 8.22×10^{18} 88.9 1.25×10^{18} 86.4 6.34×10^{17} 97.6	n (cm-3) ρ (Ω cm) μ (cm2 V-1 s-1) 1.90×10^{17} 97.0 10.7 8.88×10^{16} 97.522.8 8.22×10^{18} 88.924.7 1.25×10^{18} 86.416.2 6.34×10^{17} 97.631.9	n (cm ⁻³) ρ (Ω cm) μ (cm ² V ⁻¹ s ⁻¹)Type 1.90×10^{17} 97.0 10.7 p 8.88×10^{16} 97.522.8p 8.22×10^{18} 88.924.7p 1.25×10^{18} 86.416.2p 6.34×10^{17} 97.631.9p



Figure S2. XPS survey spectra as a function of etching time.



Figure S3. (a) SEM images (scale bar = 200 nm), (b) EDX spectra mapping, and (c) XRD pattern of FeNiOx



Figure S4. (a) Stability test of Cu₂O/Ga₂O₃ photoanode.



Figure S5. Photos of Cu_2O/β -Ga $_2O_3$ and $Ni/Au/Cu_2O/\beta$ -Ga $_2O_3$ photoelectrodes before and after the measurement.



Figure S6. (a) UPS spectra of Al/Cu₂O at valence band region with continual Ar sputtering. (b) Interfacial energy diagrams of Cu₂O and Ni/Al/Cu₂O contacted with the electrolyte. (c) Photocurrent density of $FeNiO_x/Ni/Al/Cu_2O/Ga_2O_3$.



Figure S7. XPS core level spectra of Cu2p and O1s after the long-term stability and gas evolution of FeNiOx/Au/Cu₂O/Ga₂O₃.



Figure S8. Photographic and schematic image of metal organic chemical vapor deposition setup.



Figure S9. (a)The schematic image of our photoanode with and without $FeNiO_x$. (b) the light absorption spectra of $FeNiO_x/Ni/Au/Cu_2O/Ga_2O_3$ and $Au/Cu_2O/Ga_2O_3$.