Electronic Supplementary Material (ESI) for RSC Advances.

Integration of a Cu_2O/ZnO heterojunction and Ag@SiO_2 into a photoanode for enhanced solar water oxidation

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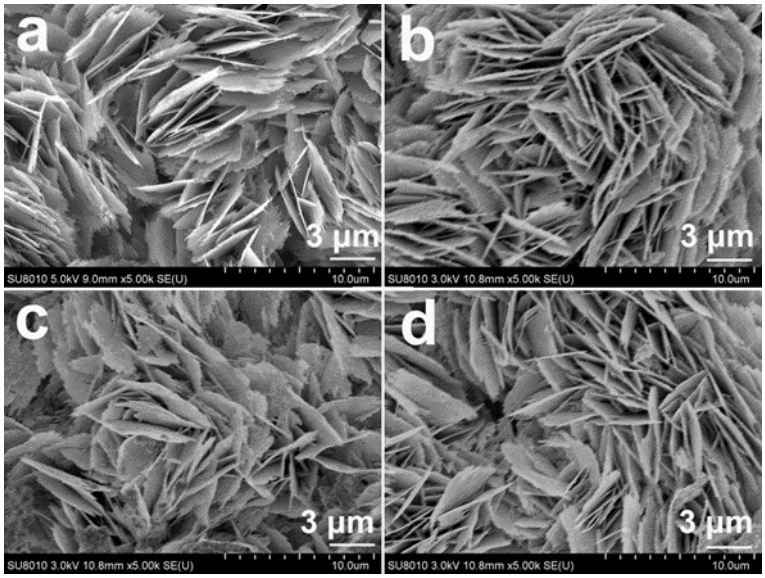


Fig. S1 The top-view SEM images of (a) FTO/ZnO, (b) FTO/ZnO/Cu_2O-1, (c) FTO/ZnO/Cu_2O-2 and (d) FTO/ZnO/Cu_2O-3 photoanodes.

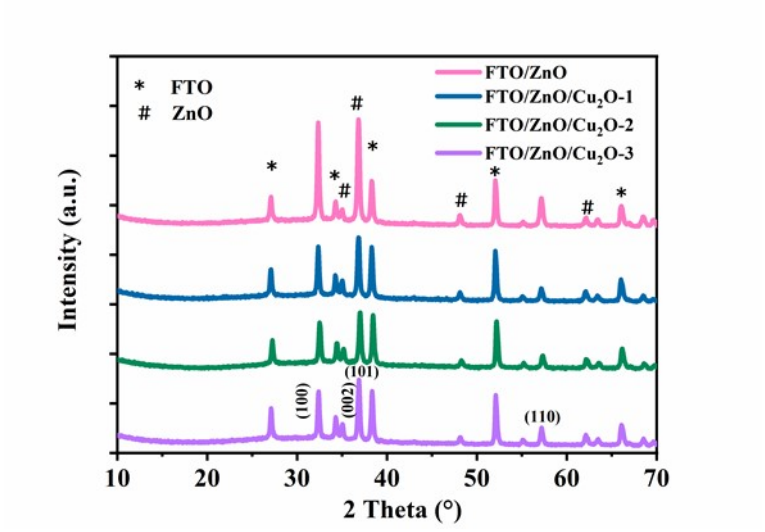


Fig. S2 The XRD patterns of FTO/ZnO, FTO/ZnO/Cu_2O-1, FTO/ZnO/Cu_2O-2 and FTO/ZnO/Cu_2O-3 photoanodes.

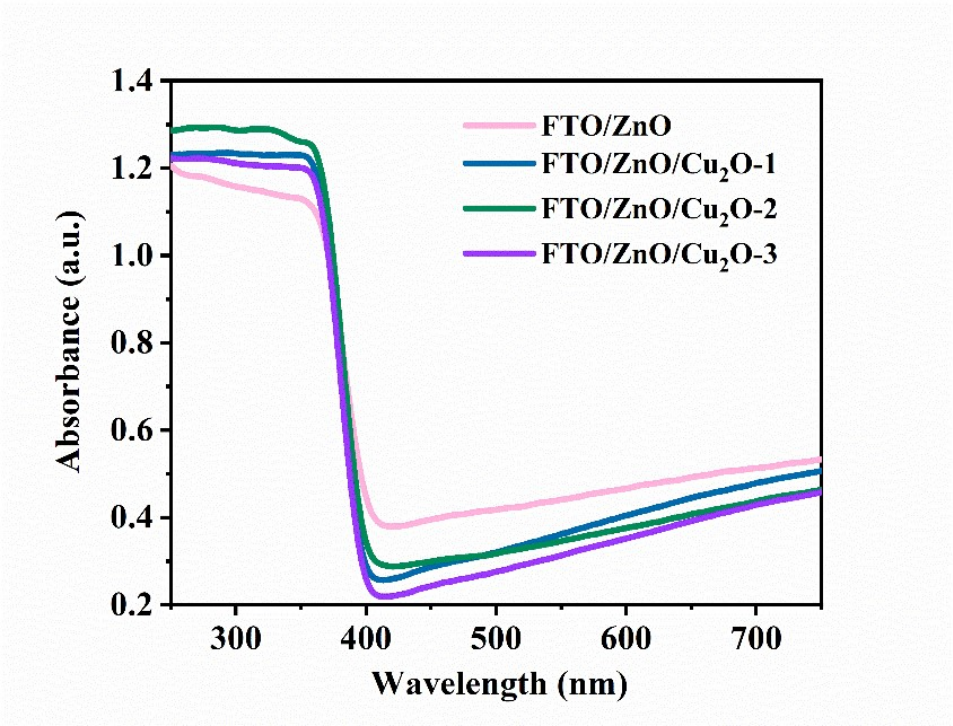


Fig. S3 The UV–vis diffuse reflectance spectra of FTO/ZnO, FTO/ZnO/Cu_2O-1, FTO/ZnO/Cu_2O-2 and FTO/ZnO/Cu_2O-3 photoanodes.

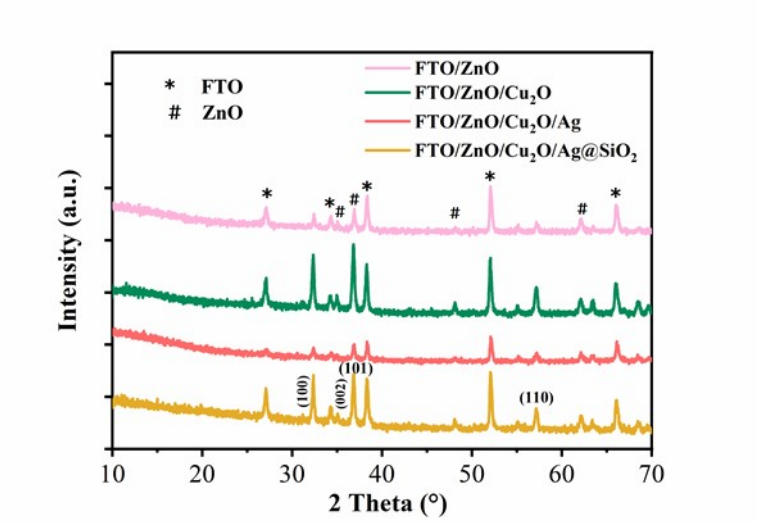


Fig. S4 The XRD patterns of FTO/ZnO, FTO/ZnO/Cu_2O, FTO/ZnO/Cu_2O/Ag and FTO/ZnO/Cu_2O/Ag@SiO_2 photoanodes.

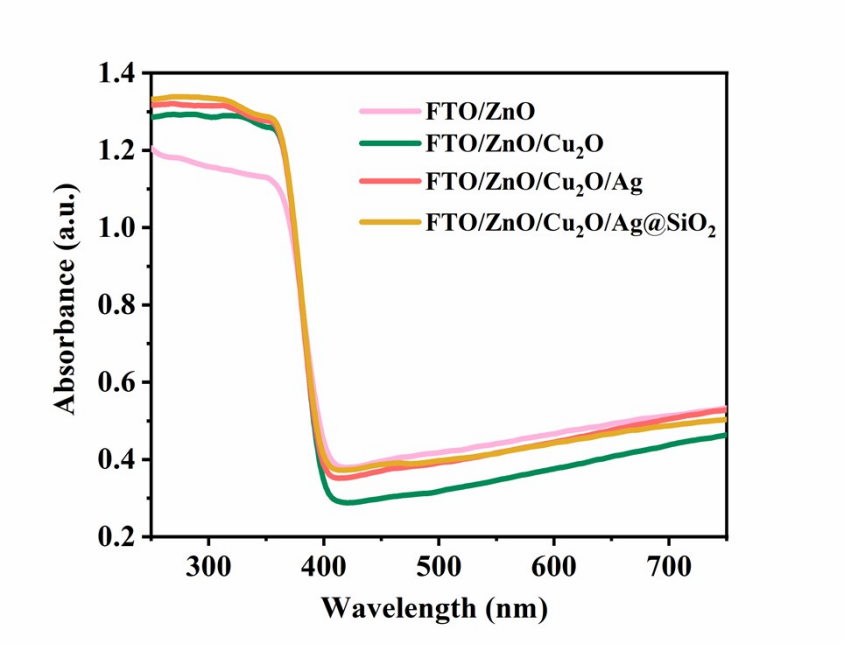


Fig. S5 The UV–vis diffuse absorbance spectra of FTO/ZnO, FTO/ZnO/Cu_2O, FTO/ZnO/Cu_2O/Ag and FTO/ZnO/Cu_2O/Ag@SiO_2 photoanodes.

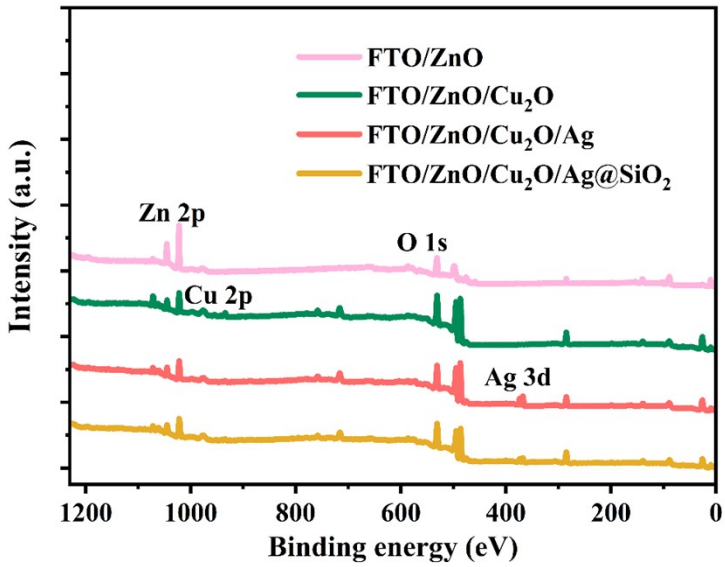


Fig. S6 XPS survey spectra of FTO/ZnO, FTO/ZnO/Cu_2O, FTO/ZnO/Cu_2O/Ag and FTO/ZnO/Cu_2O/Ag@SiO_2 photoanodes.

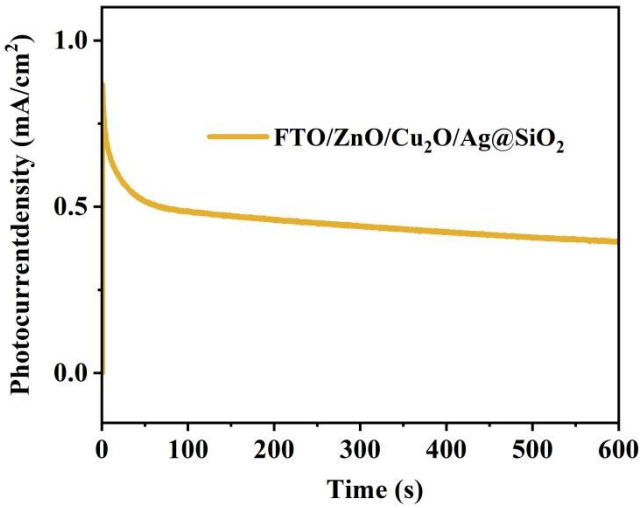


Fig. S7 *J-t* curves of the FTO/ZnO/Cu_2O/Ag@SiO_2 photoanode at 1.23 V_{RHE} for stability study.

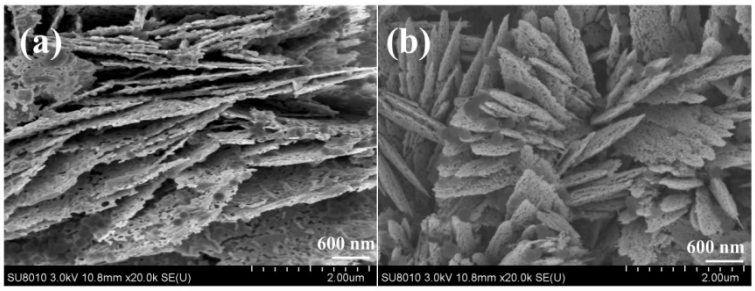


Fig. S8 The SEM images before and after stability test of FTO/ZnO/Cu_2O/Ag@SiO_2 photoanode.

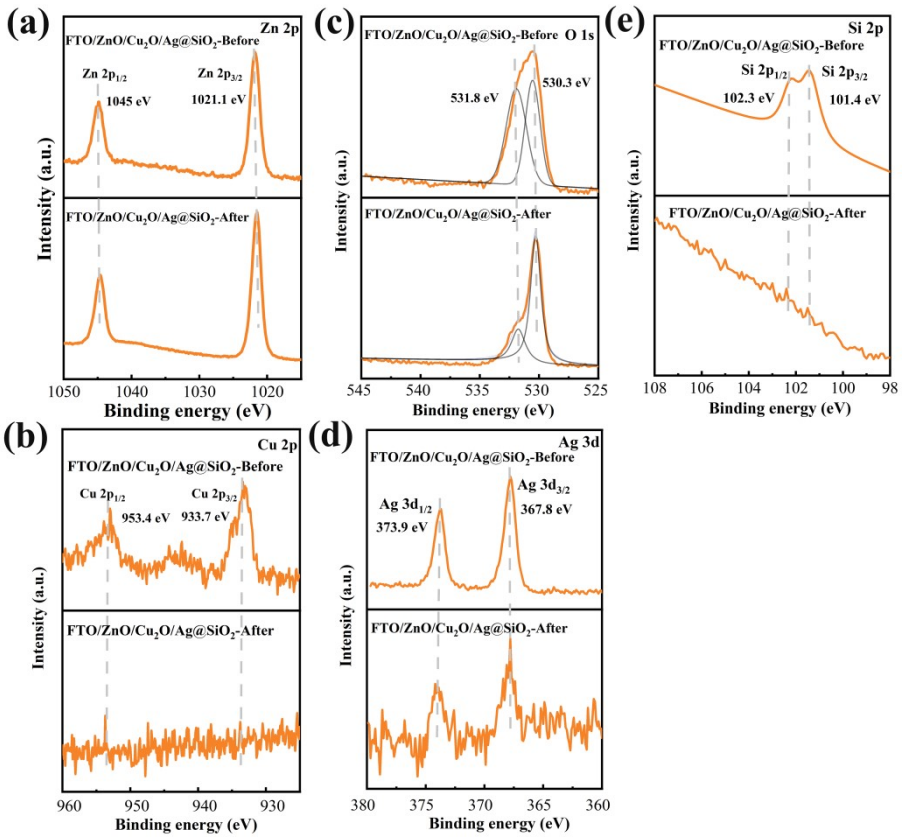


Fig. S9 The XPS spectra before and after stability test of FTO/ZnO/Cu_2O/Ag@SiO_2 photoanode.

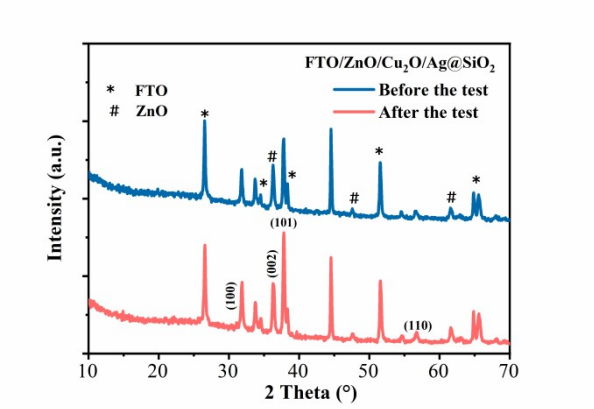
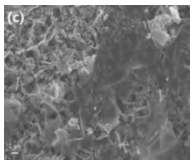
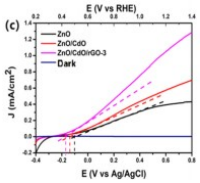
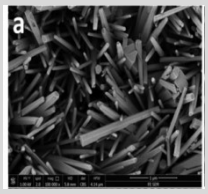
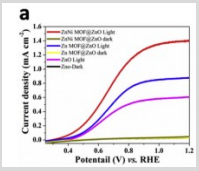
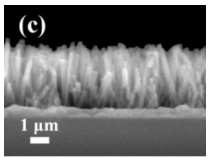
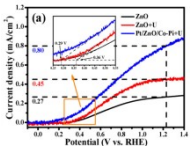
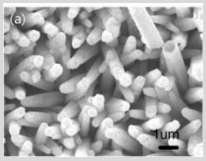
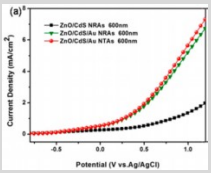
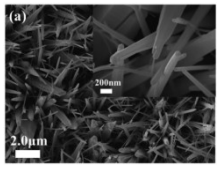
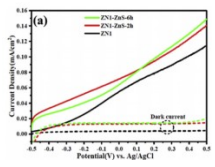
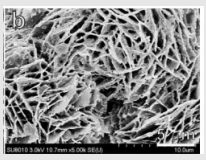
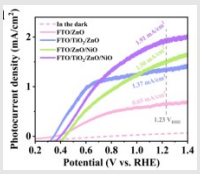
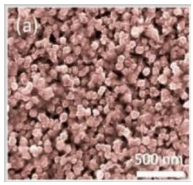
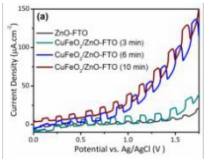
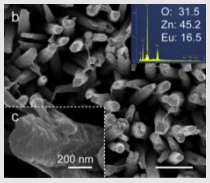
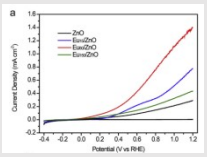
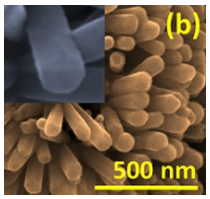
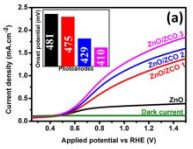
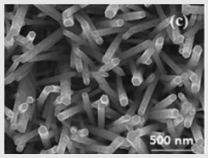
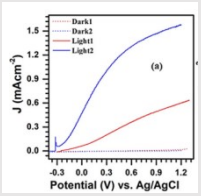
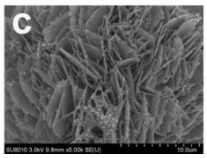
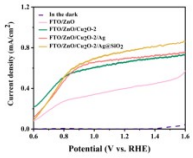


Fig. S10 The XRD patterns before and after stability test of FTO/ZnO/Cu_2O/Ag@SiO_2 photoanode.

Tab. S1 A comparison of the PEC-WS performances between the ZnO photoanodes in the related literature and our present FTO/ZnO/Cu_2O/Ag@SiO_2 photoanode.

Photoanode	Film texture	Optimized sample (*J-V* curves)	$J_{ph@1.23V}$ U_{on}	Testing conditions (Under AM 1.5G irradiation)	Key Method	Ref.
ZnO/CdO/rGO			0.38 mA/cm^2 -0.2 V (vs. Ag@AgCl)	0.5 M Na_2SO_4	thermal decomposition and spin coating	[1]
ZnNi MOF @ZnO			0.88 mA/cm^2 0.3 V_{RHE}	0.5M Na_2SO_4	hydrothermal	[2]
Pt/ZnO/Co-Pi			0.8 mA/cm^2 0.07 V_{RHE}	0.1 M K_3PO_4	hydrothermal and photoelectrode position	[3]
ZnO/CdS/Au			1 mA/cm^2 -0.5 V（vs. Ag@AgCl)	0.25 M Na_2S 0.35 M Na_2SO_3	chemical bath deposition and sulfuric acid corrosion	[4]
ZnO/ZnS			0.08 mA/cm^2 -0.5 V （vs. Ag/AgCl)	0.5 M Na_2SO_3	hydrothermal	[5]
FTO/TiO_2/ZnO/NiO			1.91 mA/cm^2 0.35 V_{RHE}	1.0 M NaOH	atomic layer deposition and immersion	[6]

$ZnO/CuFeO_2$			54 μA/cm^2 0.5 V (Ag/AgCl)	0.5 M Na_2SO_4	spin coating and electrochemically depositing	[7]
Eu_{150}/ZnO			1.4 mA/cm^2 0.3 V_{RHE}	0.5M Na_2SO_4	electrodeposition	[8]
ZnO/ZCO			1.58 mA/cm^2 0.5 V_{RHE}	0.5 M Na_2SO_4	two-step aqueous chemical bath growth and electrodeposition	[9]
ZnO/CoO			1.25 mA/cm^2 -0.3 V (vs. Ag@AgCl)	10, 30 mM borax with sodium hydroxide	ALD and CBD and ECD	[10]
$FTO/ZnO/Cu_2O/Ag@SiO_2$			0.77 mA/cm^2 0.4 V_{RHE}	1.0 M NaOH	hydrothermal and immersion	**This work**

Reference

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[9] D. Maity, K. Karmakar, D. Pal, S. Saha, G. G. Khan and K. Mandal, *ACS Appl. Energy Mater*., 2021, **4**, 11599−11608.

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