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Goethite and Hematite Hybrid Nanosheet Decorated YZnO NRs for Efficient Solar Water Splitting

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Supplemental Information

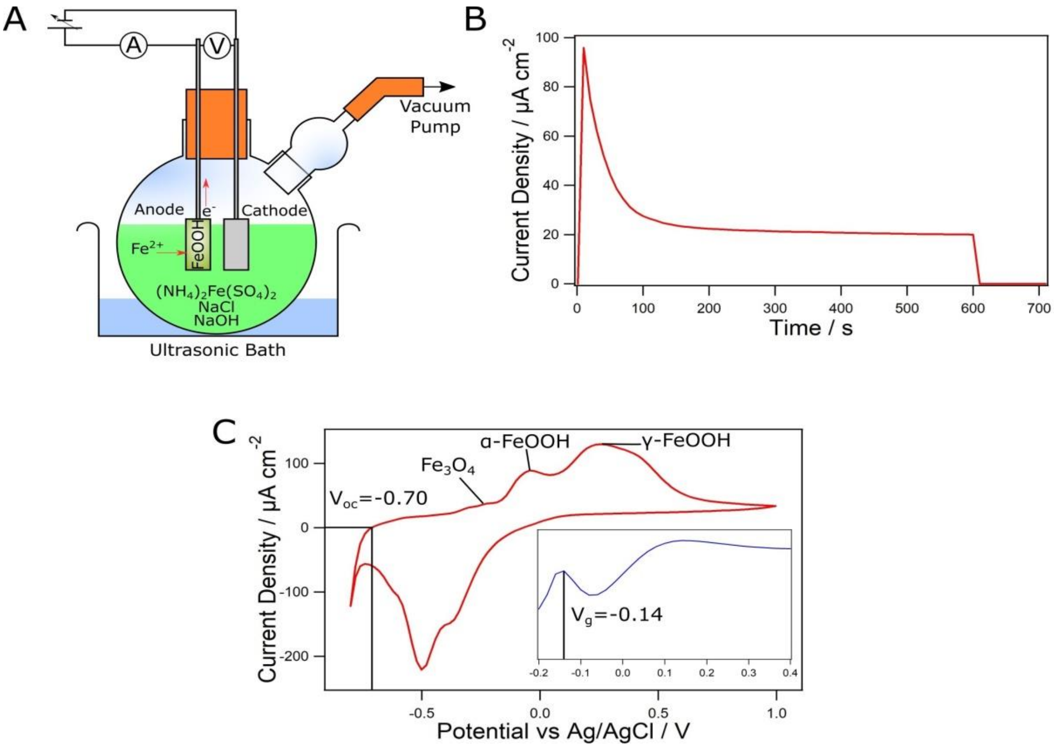

Figure S1: Schematic diagram of the deposition process, A, showing the setup including ultrasonic bath, and electrode positions. B Shows typical deposition current over time, integrated to calculate charge density. C Shows the cyclic voltammetry with three electrode setup, used to determine the goethite potential, inset shows a slower scan speed linear sweep for greater accuracy.[1] Electrode deposition potential was determined by the difference between V_{oc} (-0.70) and goethite deposition potential (-0.14) as 0.56 V.

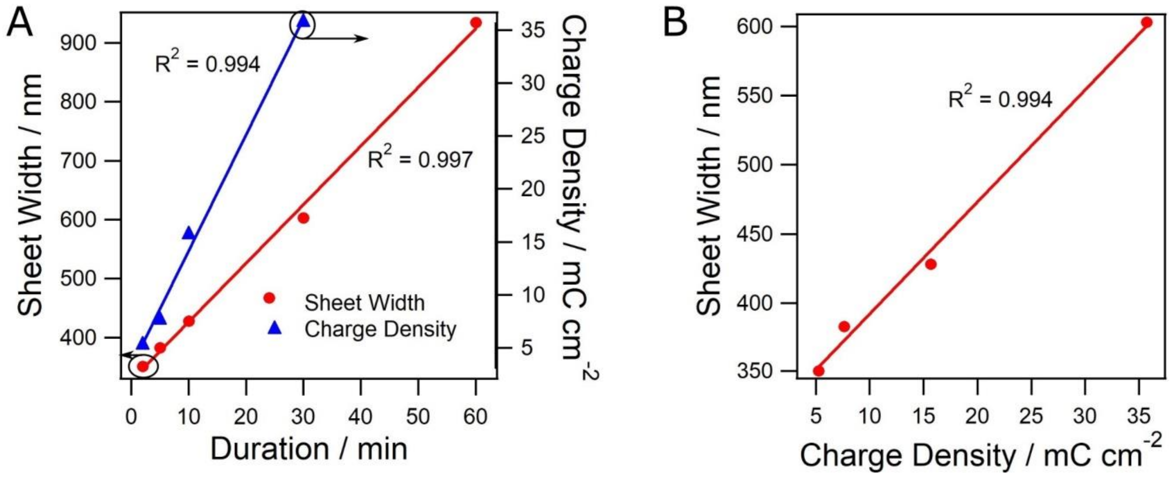

Figure S2: A Shows the integrated total charge density deposited and the nanosheet width against the duration of deposition. B Shows the charge density plotted against nanosheet width.

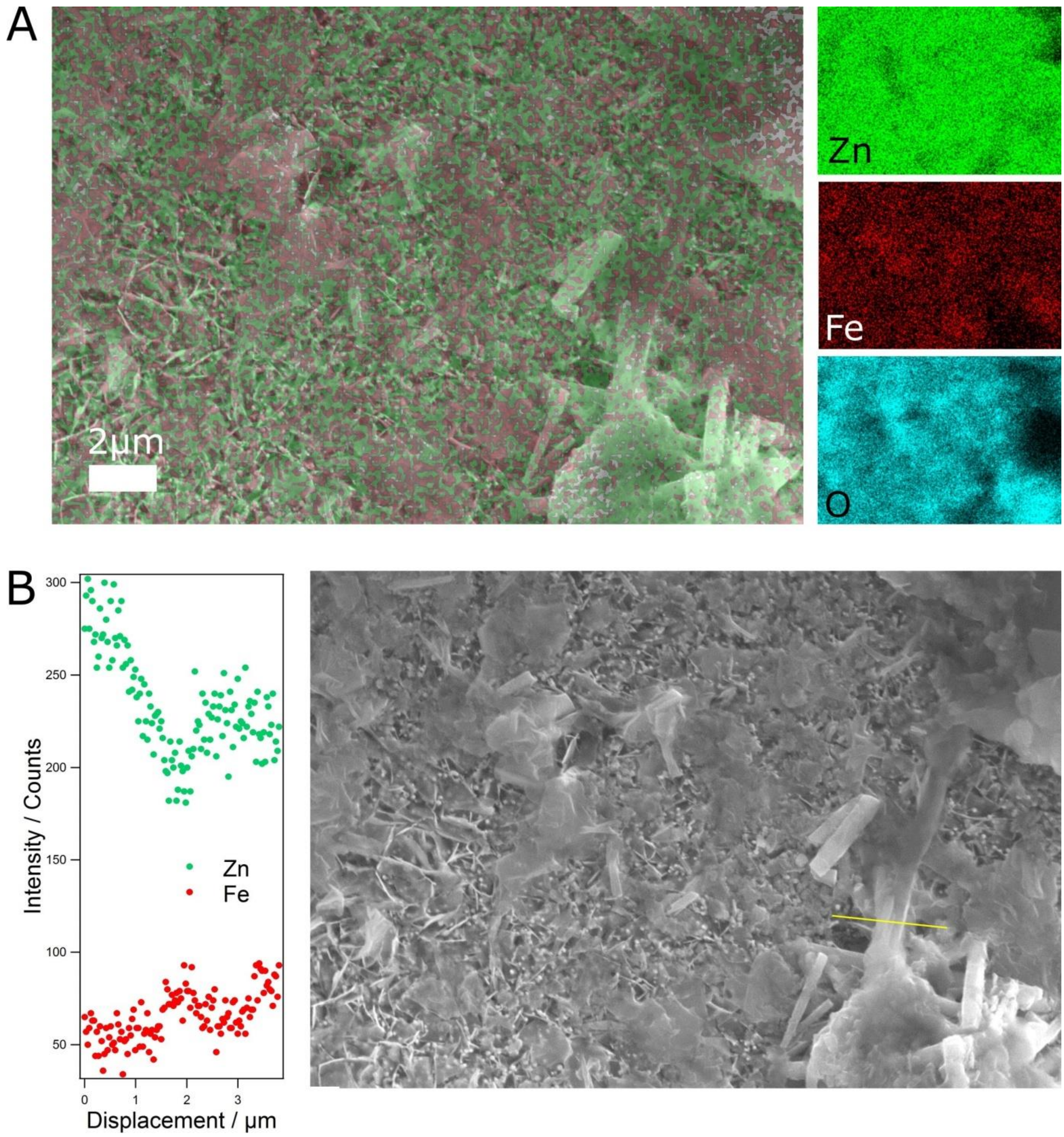

Figure S3: A Shows EDX mapping of the sample area of the 30 min deposition, with composite image of Zn and Fe (left) and component elements (right). B Shows an EDX line scan of Fe_2O_3 / FeOOH aggregates on the surface.

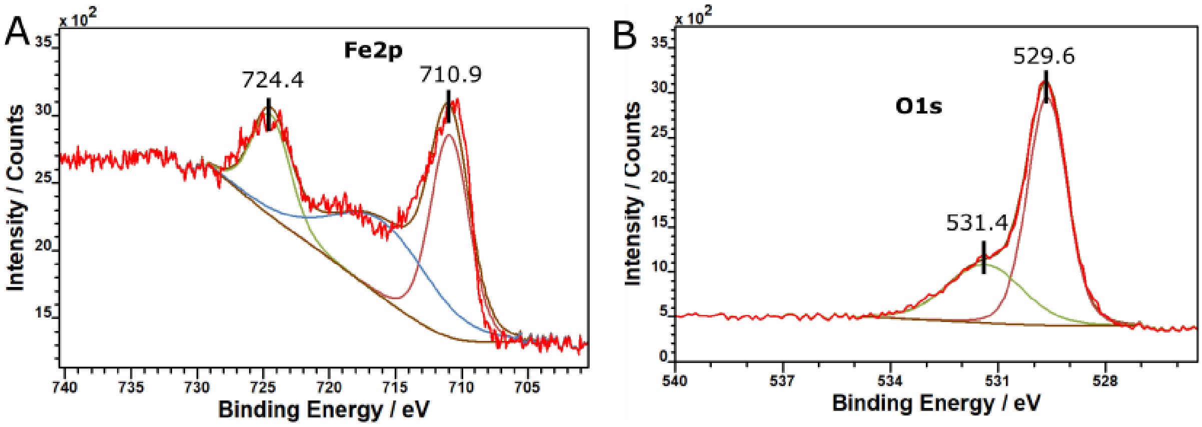

Figure S4: Shows the XPS high resolution scans for Fe2p and O1s in the Fe_2O_3 / FeOOH sample.

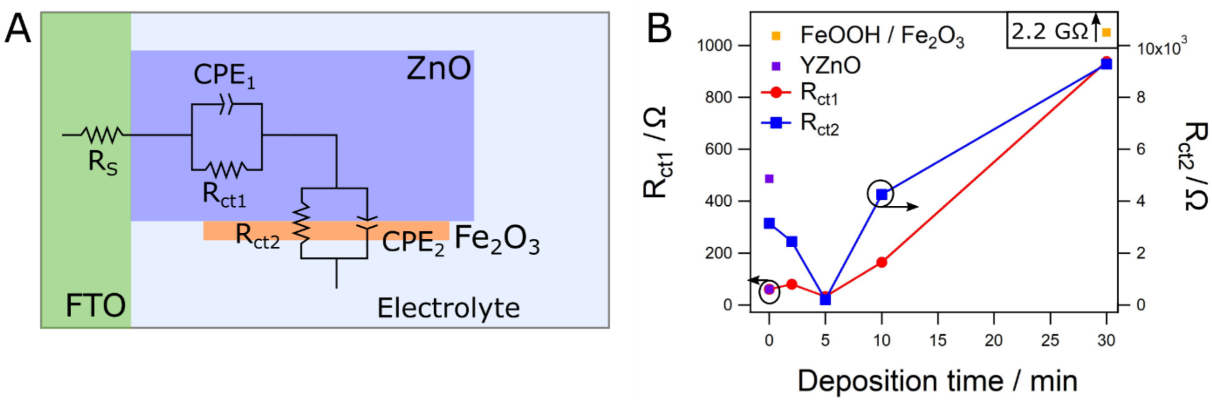

Figure S5: A Shows the equivalent circuit used to fit the Nyquist plots, and B shows the different R_{ct} values plotted against deposition duration, along with pure samples.

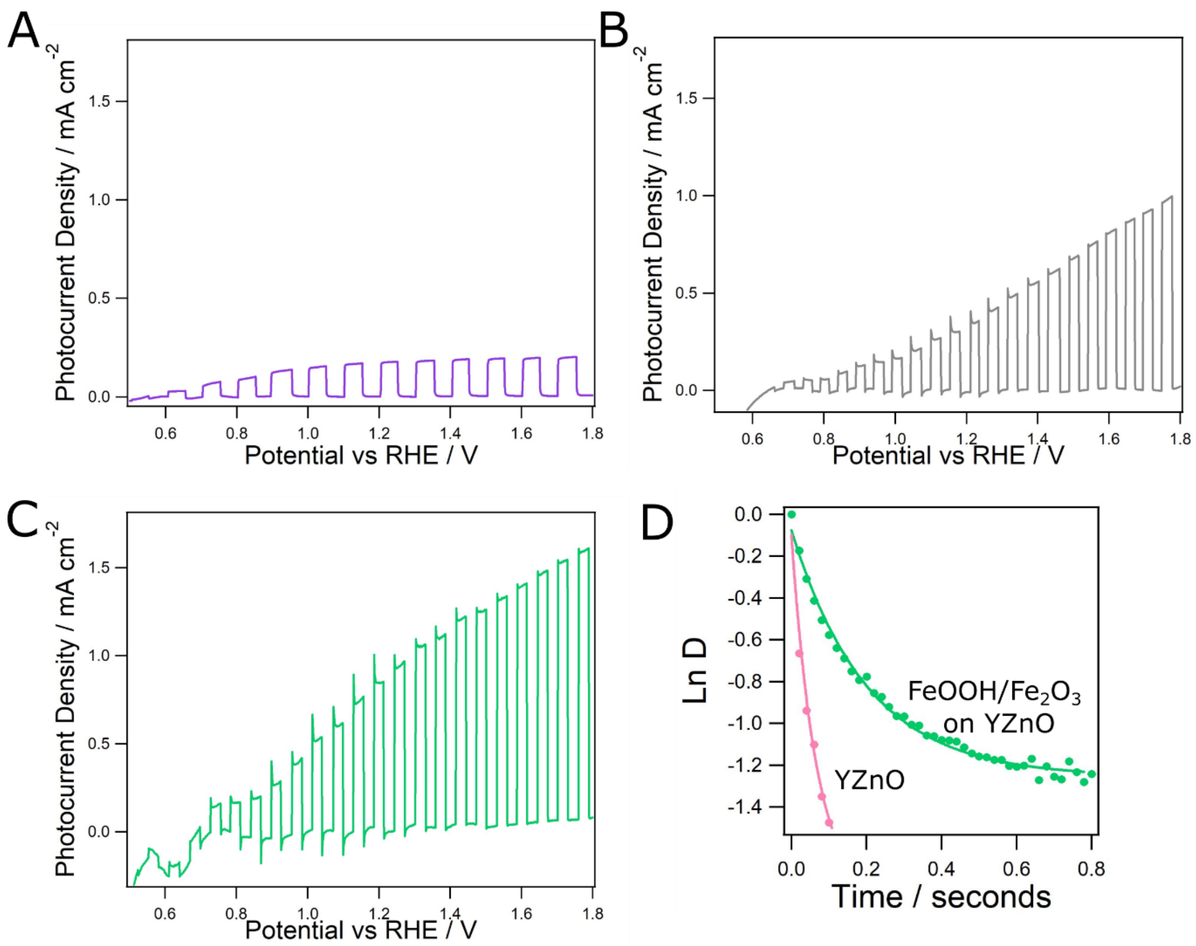

Figure S6: Shows the light/dark stepped linear sweep voltammetry of a comparative selection of anodes, with pristine ZnO A, and 5 minutes electrodeposition on pure ZnO B. C Shows the top performing sample, 5 minutes deposition on Y doped nanowires. Finally D shows the normalised logarithm of current decay from the chronoamperometry measurements.

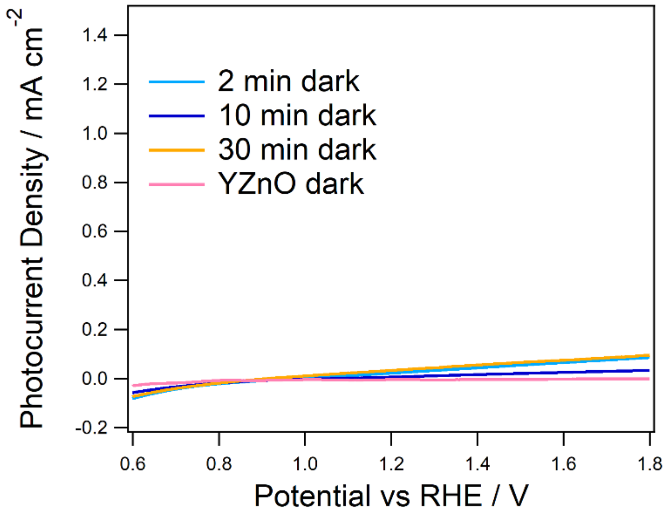

Figure S7: Shows the comparison of all the dark currents for the optimisation.

Table S1: Displays a literature comparison of relevant structures and devices.

No.	Sample Description	Photocurrent Density at 1.23 V_{RHE}	Reference
1	NiO-ZnO on Fe_2O_3 films	Negligible	Zhang *et al.*[2]
2	ZnO quantum dots on Fe_2O_3 films	Negligible	Ikram *at al.*[3]
3	ZnO NRs covered in Fe_2O_3 nanoparticles	Negligible	Chakraborty *et al.*[4]
4	ZnO NRs coated with Fe_2O_3, prior to Fe_2PO_4 encapsulation	0.85 mA cm^{-2}	Qin *et al.*[5]
5	ZnO NRs coated with Fe_2O_3	1.27 mA cm^{-2}	Hsu *et al.*[6]
6	This Work	0.91 mA cm^{-2}	n/a
7	Silicon doped nanostructured Fe_2O_3 films	2.2 mA cm^{-2}	Kay *et al.*[7]

8	Co-doped ZnO nanorods with a transparent functionalizing MOF	0.15 mA cm^{-2}	Galan-Gonzalez *et al*.[8]
9	Sn doped Fe_2O_3 from FTO	1.0 mA cm^{-2}	Annamalai *et al*.[9]
10	Zinc Ferrite modified Al-doped ZnO NR Arrays	1.72 mA cm^{-2}	Xu *et al*.[10]

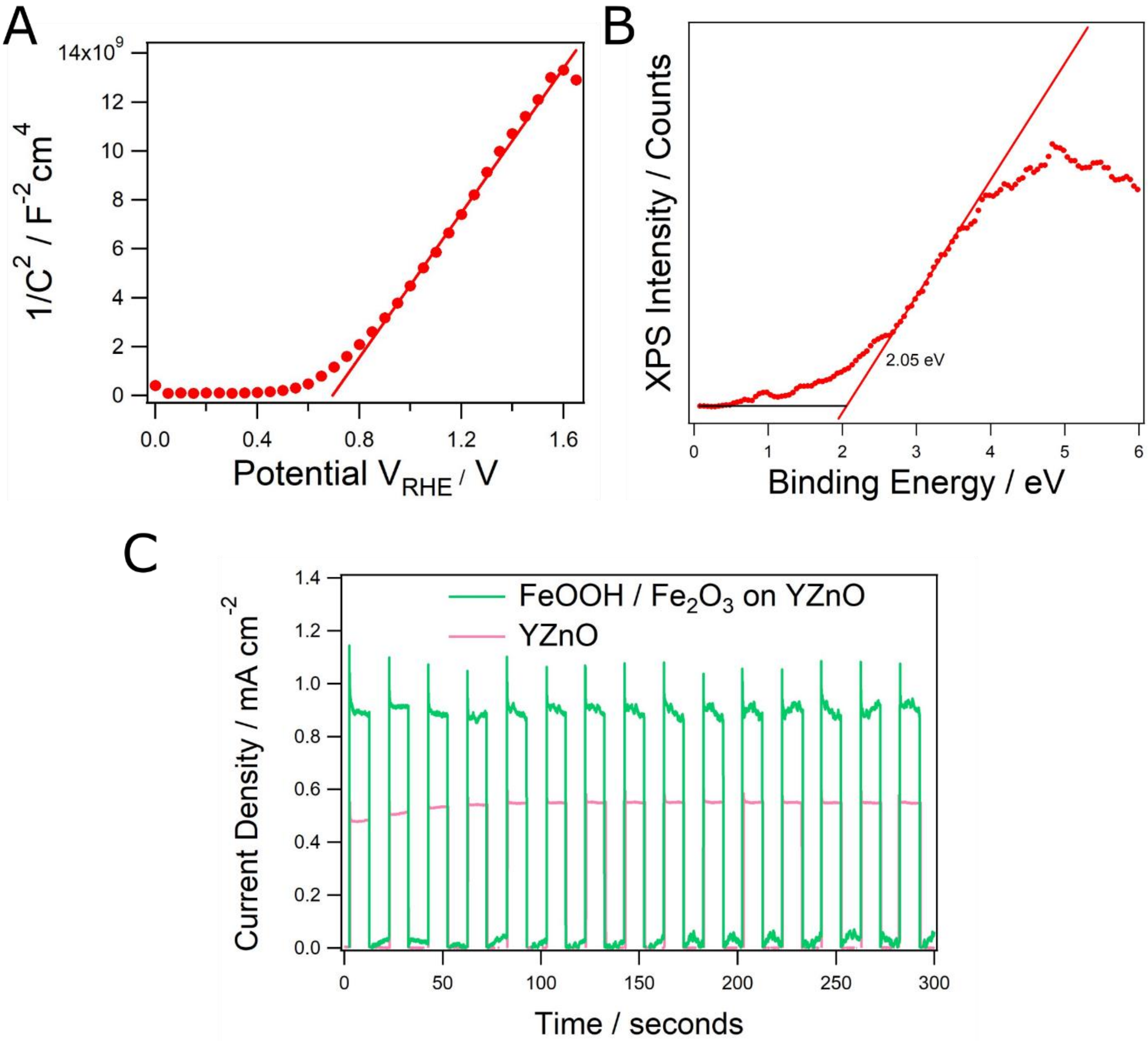

Figure S8: A shows the Mott-Schottky plot of the anodic deposition of Fe_2O_3, yielding V_{FB}

value of 0.69 V_{RHE} and dopant density of 1.19×10^{26} m^{-3}. B shows the XPS survey scan of the hybrid junction and valence band determination, finally C shows the chopped illumination chronoamperometry test over a five minute period.

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