Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Strong Bifunctional Electrocatalytic Active Hybrid Cu-Cu_2O Nanoparticles Fabrication in Carbon Matrix and Comparing Activity with Pure Cu_2O and Cu Nanoparticles

Pandi Muthukumar, Vadivel Vinod Kumar, Gajjala Rajendra Kumar Reddy, P. Suresh Kumar and Savarimuthu Philip Anthony*

School of Chemical & Biotechnology, SASTRA University, Thanjavur-613401, Tamil Nadu, India. Fax: +914362264120; Tel: +914362264101; E-mail: philip@biotech.sastra.edu

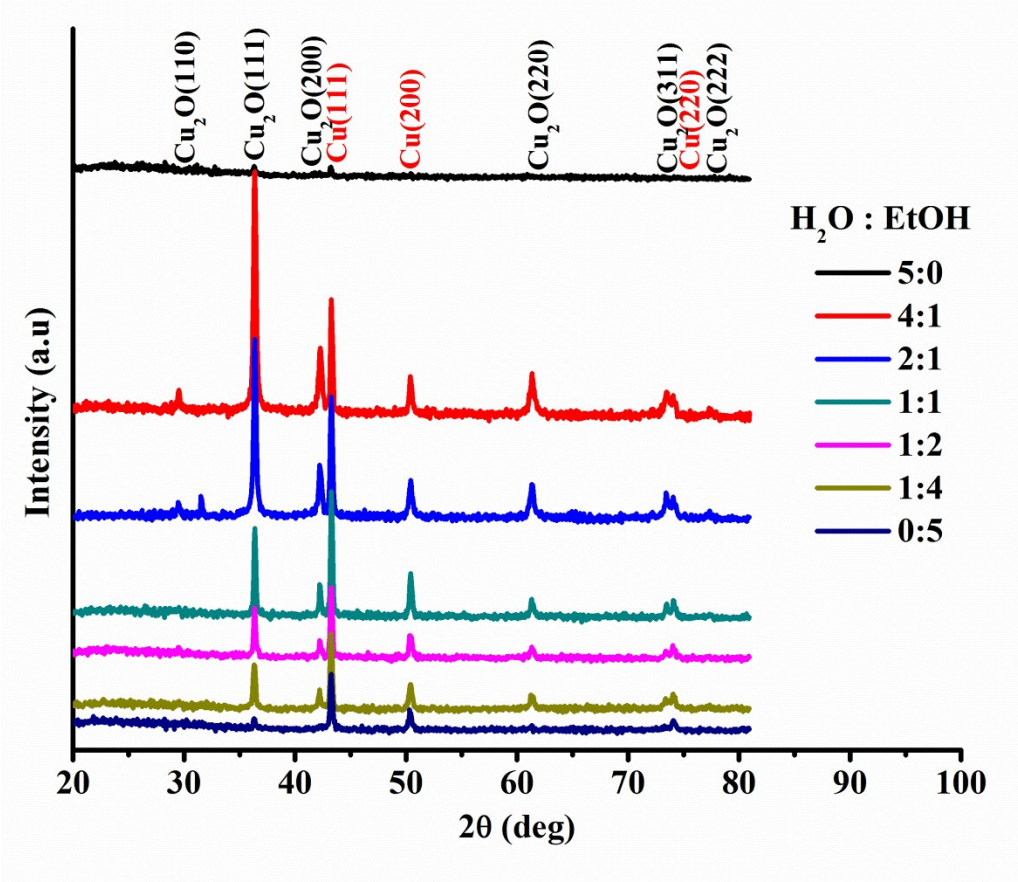

Figure S1. PXRD pattern of hybrid Cu-Cu_2ONPs@C synthesized at different ethanol: water fractions.

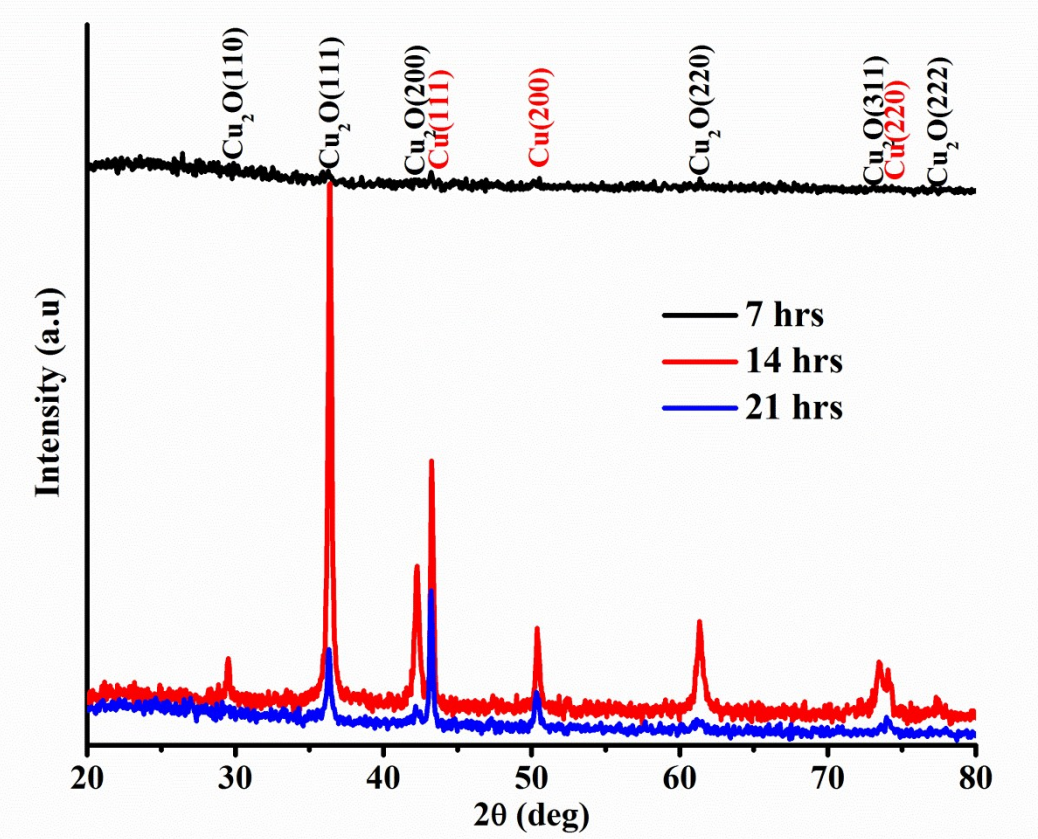

Figure S2. PXRD pattern of hybrid Cu-Cu_2ONPs@C synthesized at different times.

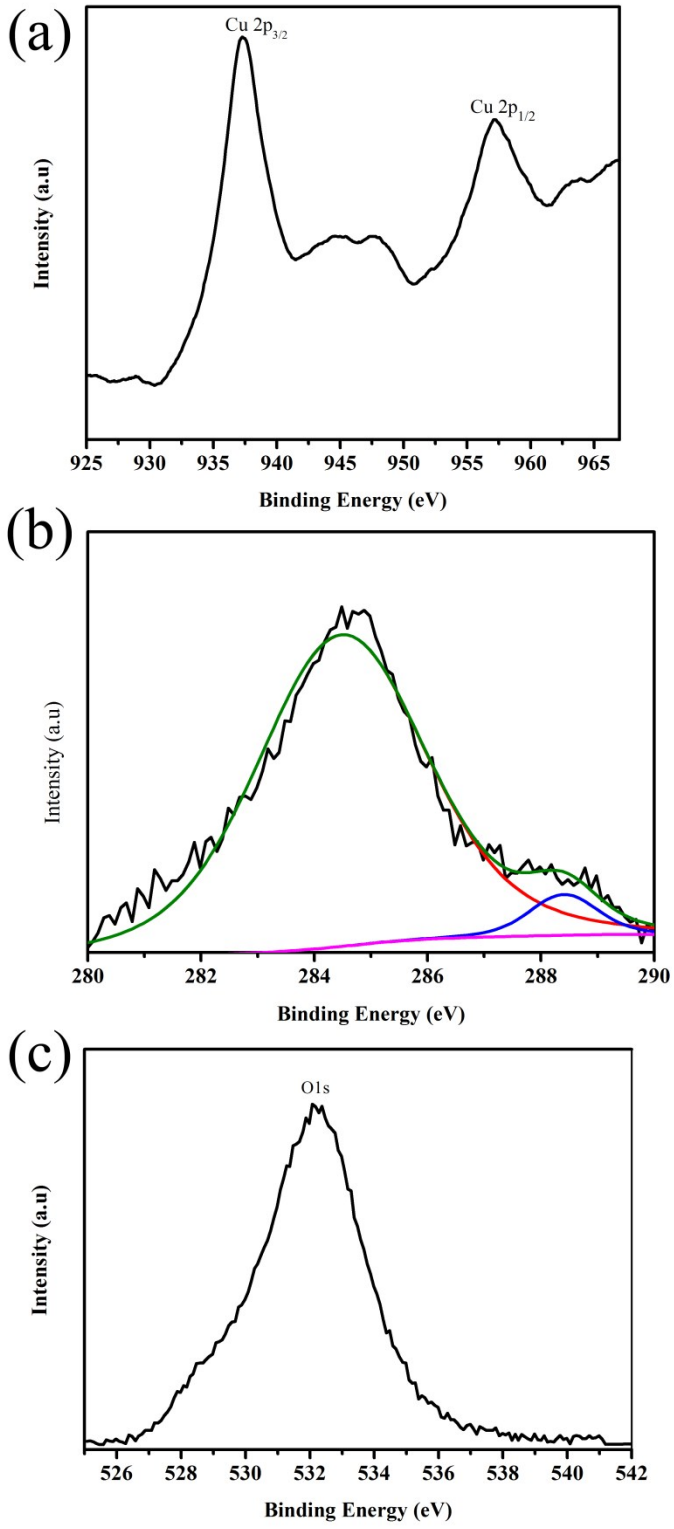

Figure S3. High resolution XPS spectra of Cu_2ONPs @ Cu2p, (b) C1s and (c) O1s in the carbon matrix.

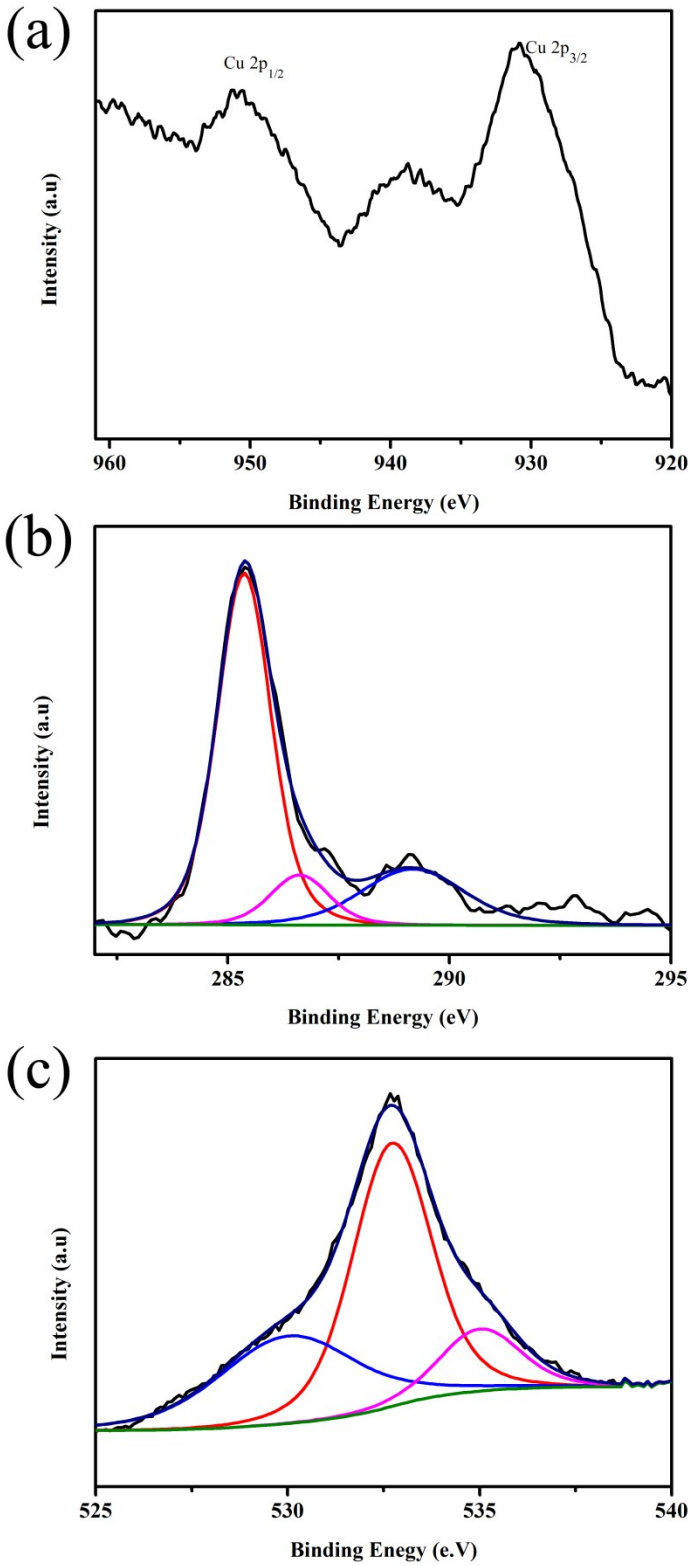

Figure S4. High resolution XPS spectra of CuNPs@C (a) Cu2p, (b) C1s and (c) O1s in the carbon matrix.

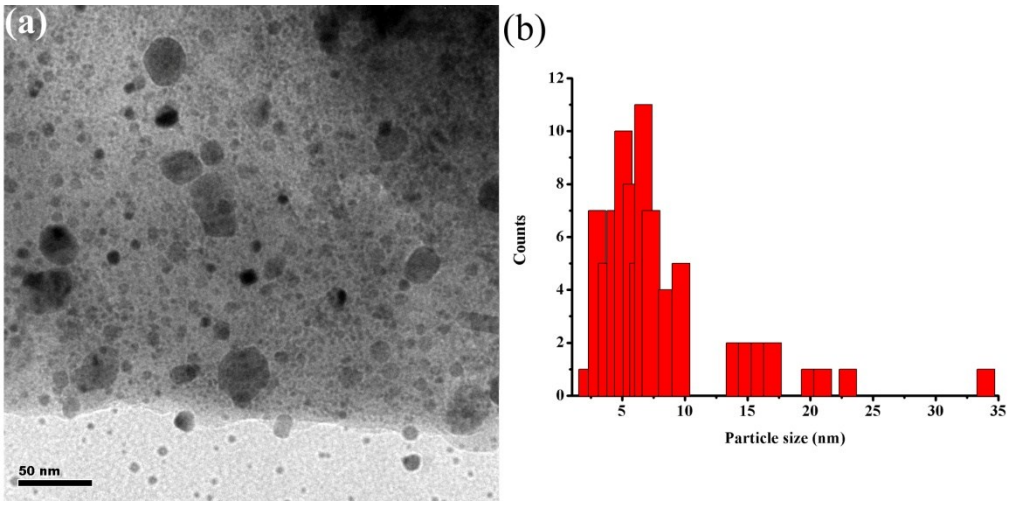

Figure S5. HR-TEM (a) and histogram (b) images of hybrid Cu-Cu_2ONPs@C synthesized 1:4 ethanol: water fractions.

Table S1. Comparison of BET and electrochemical surface area.

	BET surface area (m^2/g)	Electrochemical surface area
Cu-Cu_2ONPs@C	14.423	16.49
Cu_2ONPs@C	8.580	8.60
CuNPs@C	2.768	2.86

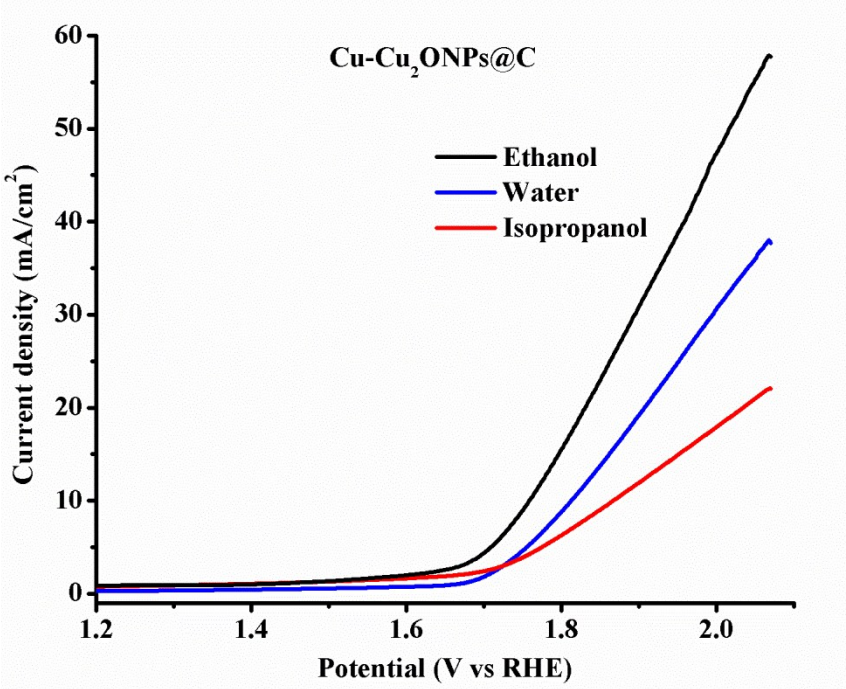

Figure S6. Polarization curves of LSV using Cu-Cu_2ONPs@C-CPE in 0.4 M KOH at 50 mV/s scan rate.

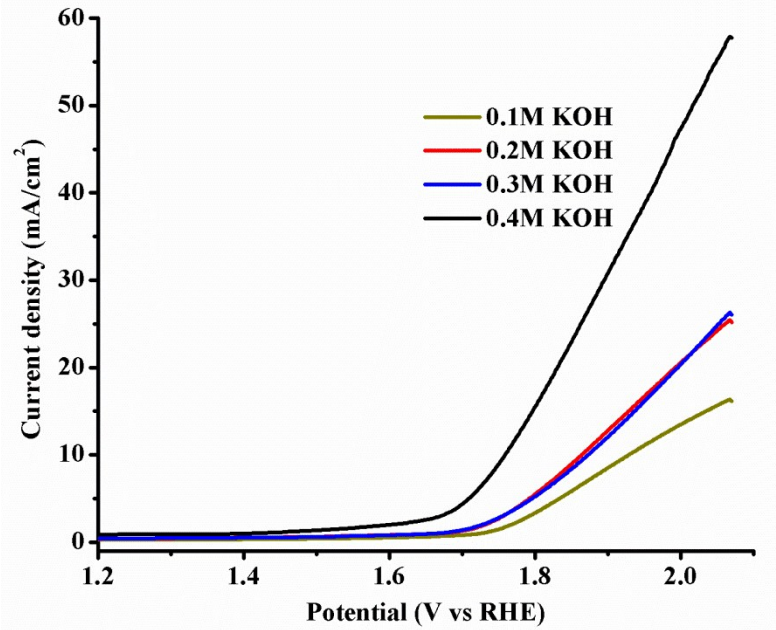

Figure S7. Polarization curves of LSV using Cu-Cu_2ONPs@C-CPE in 0.4 M KOH at 50 mV/s scan rate.

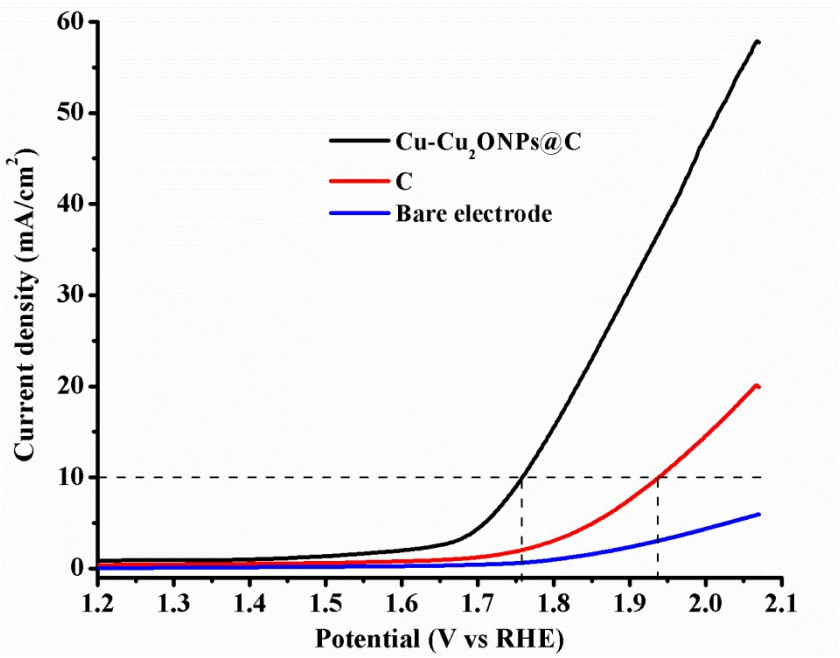

Figure S8. Polarization curves of LSV using in 0.4 M KOH at 50 mV/s scan rate.

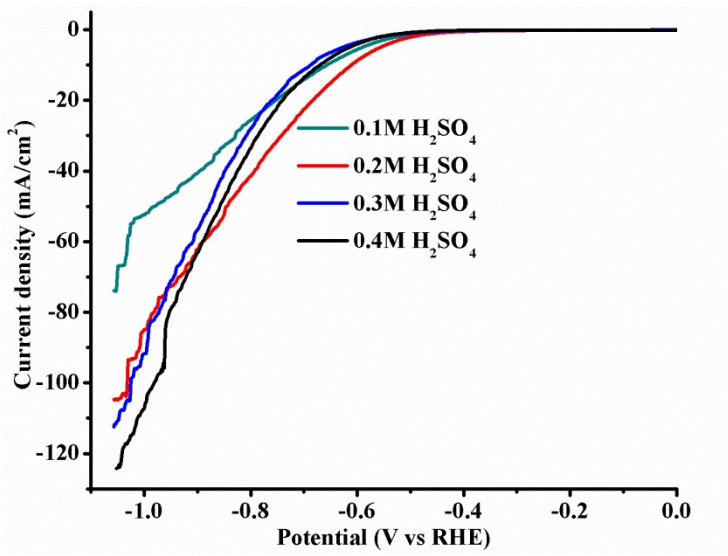

Figure S9. LSV of Cu-Cu_2ONPs@C in difference concentration of H_2SO_4, at a scan rate of 50 mV/s.

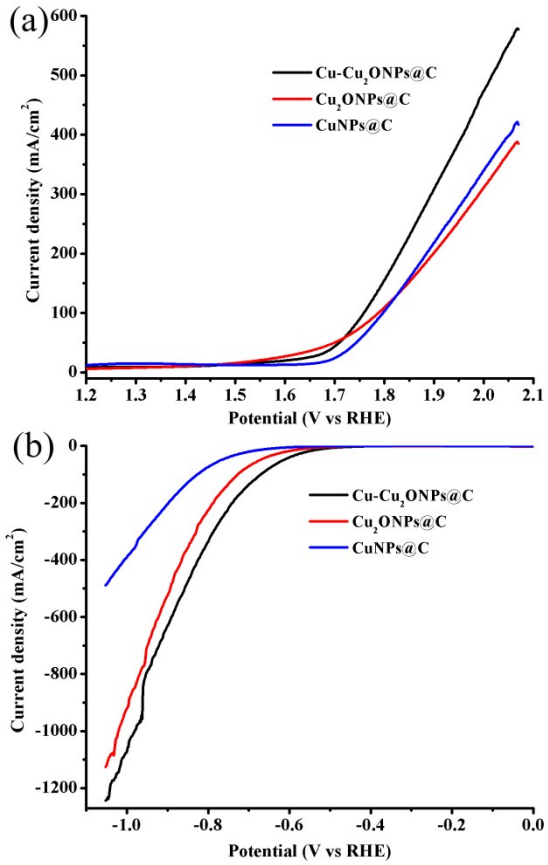

Figure S10. Estimated (a) OER and (b) HER current response of different NPs@C-CPEs at a scan rate of 50 mV/s for 1 mg loading.

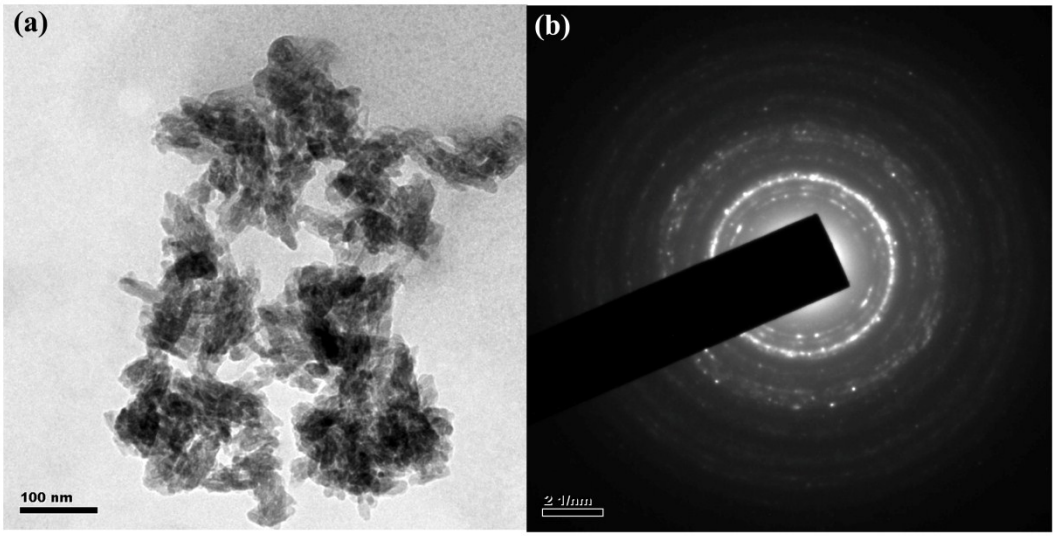

Figure S11. (a) HR-TEM image and (b) SAED pattern of Cu-Cu_2ONPs@C after OER studies.

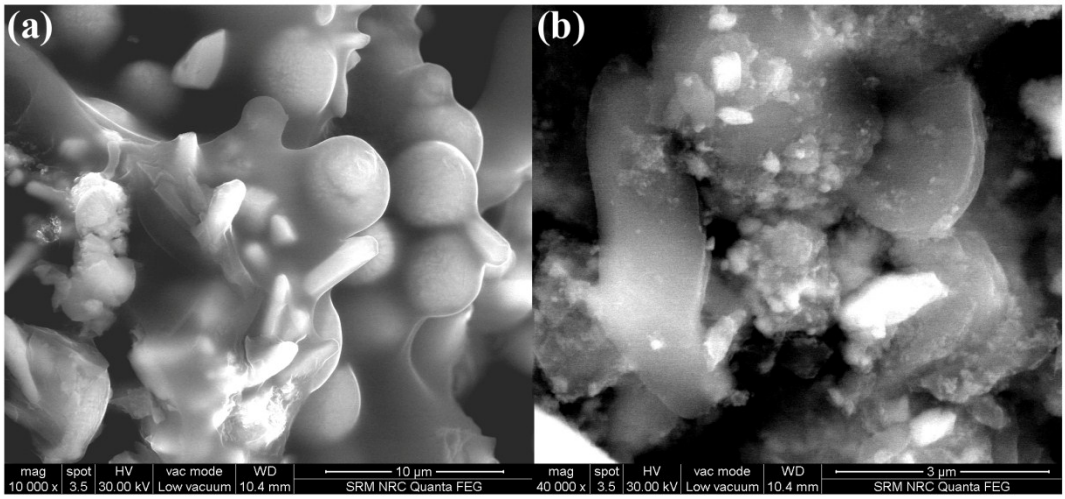

Figure S12. FE-SEM images of Cu-Cu_2ONPs@C (a) before and (b) after OER studies.

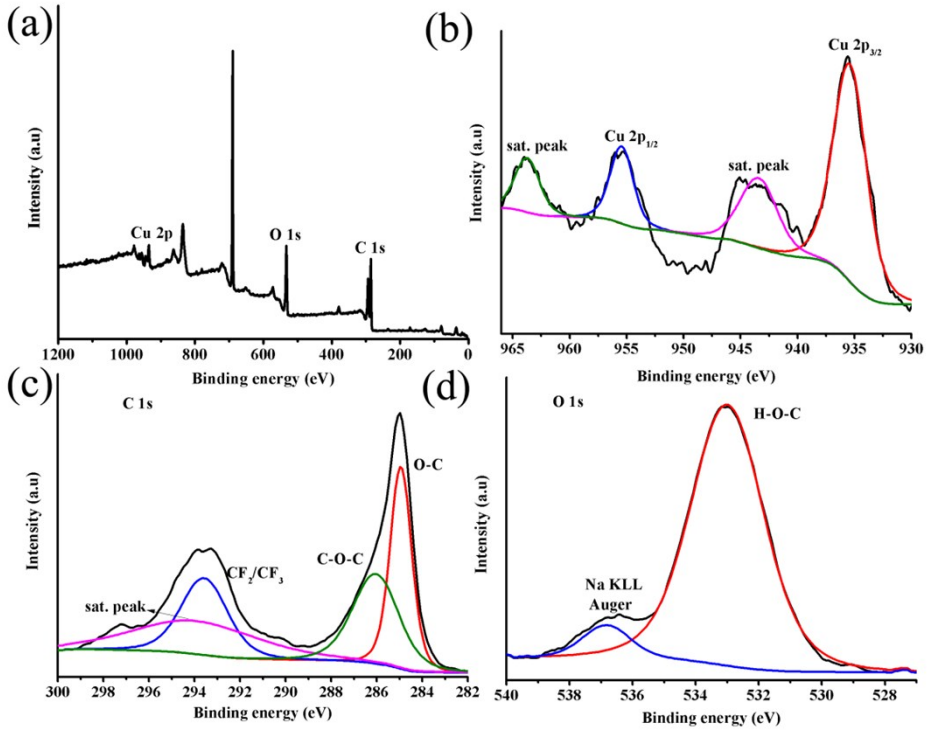

Figure S13. (a) Complete XPS spectra of hybrid Cu-Cu_2ONPs@C, (b) high resolution spectra of Cu 2p and (C) C1s and (d) O1s after OER studies.