

## Supporting Information for

### **Snowflake relocated Cu<sub>2</sub>O electrocatalyst on Ag backbone template for the production of liquid C<sub>2+</sub> chemicals from CO<sub>2</sub>**

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Table S1. Faradaic efficiencies of the liquid C<sub>2+</sub> products of 2 hr CO<sub>2</sub>RR depend on applied potential

Products	FE (%) at applied potential (V <sub>RHE</sub> )				
	-1.1	-1.2	-1.3	-1.35	-1.4
Acetaldehyde (CH <sub>3</sub> CHO)	5.06	7.17	6.76	7.29	2.88
Ethanol (C <sub>2</sub> H <sub>5</sub> OH)	2.51	2.77	5.91	4.07	0.55
1-propanol (C <sub>3</sub> H <sub>7</sub> OH)	1.7	2.32	3.38	2.31	0.57
Propionaldehyde (C <sub>2</sub> H <sub>5</sub> CHO)	1.19	0.61	1.71	0.62	0.31
Allylic alcohol (C <sub>3</sub> H <sub>5</sub> OH)	1.21	1.82	3.18	1.83	0.42
Butyraldehyde (C <sub>4</sub> H <sub>7</sub> CHO)	0.13	0.16	0.31	0.13	0.03

Table S2. Comparison of the CO<sub>2</sub>RR production rate of Cu-based catalysts

Electrocatalyst	Electrolytes	Electrode area (cm <sup>2</sup> )	Potentials (V vs. RHE)	Current Density (mA cm <sup>-2</sup> )	FE <sub>C2+</sub> liquid products (%)	Production rate (μmol h <sup>-1</sup> )	References
Cu <sub>2</sub> O-Ag	0.5 M KHCO <sub>3</sub>	9	-1.3	21.37	21.24	125.01	This work
Ag-Cu <sub>2</sub> O <sub>PB</sub>	0.1 M KHCO <sub>3</sub>	4	-1.2	-2	38.17	12.73	5
Cu-SA/NPC	0.1 M KHCO <sub>3</sub>	6	-0.36	-0.5	39.6	6.21	23
1-CuCNT-ImR	0.5 M KHCO <sub>3</sub>	5.7	-2	-5	72.8	0.29	24
NDD <sub>L</sub> /Si RA	0.5 M NaHCO <sub>3</sub>	-	-0.8	-6	77.6	24.43	25

Table S3. XPS survey scan results of as-prepared Cu<sub>2</sub>O-Ag and after the CO<sub>2</sub>RR for 2 hr at -1.3 V<sub>RHE</sub>.

Sample	Atomic Concentration (%)			
	Ag 3d5	C 1s	Cu 2p3	O 1s
As prepared	3.26	52.95	13.24	30.55
After CO <sub>2</sub> RR	0.28	50.31	13.05	36.36

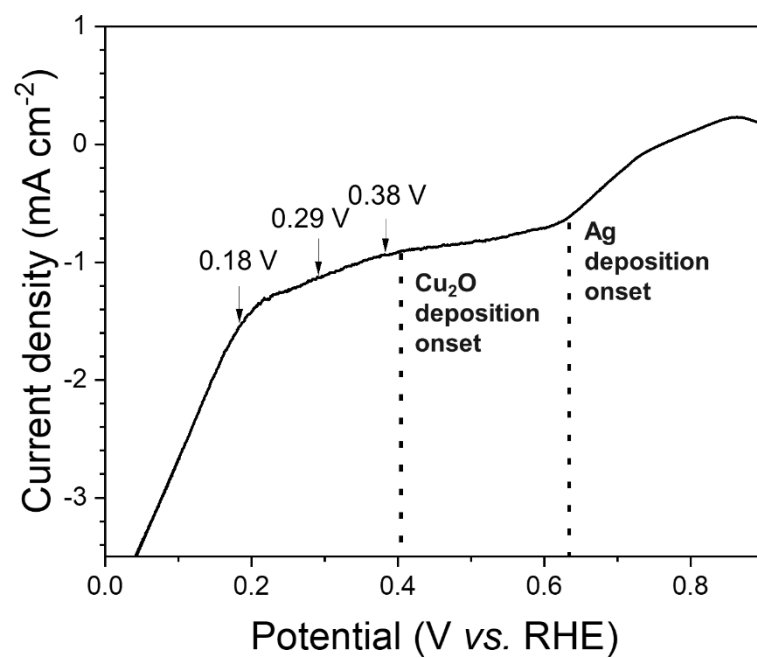
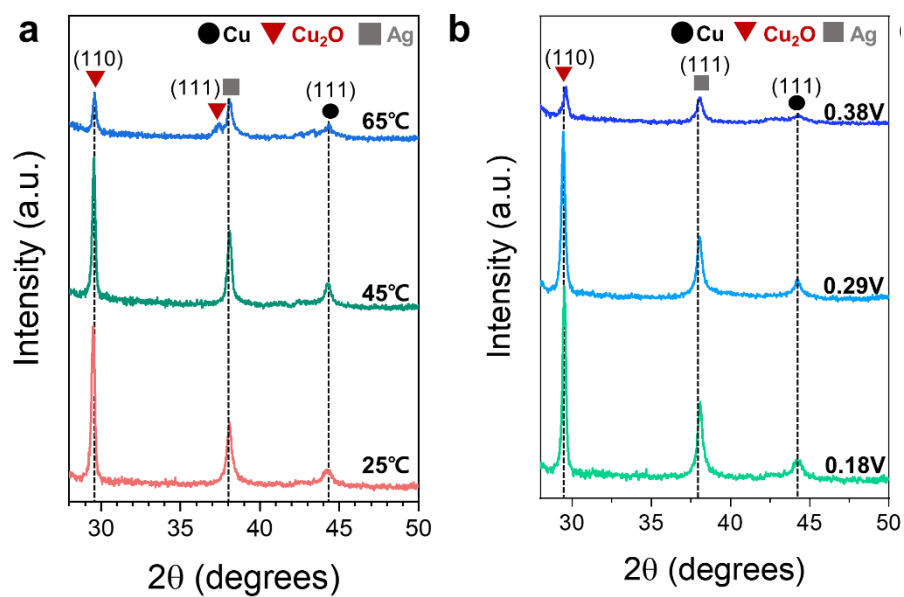
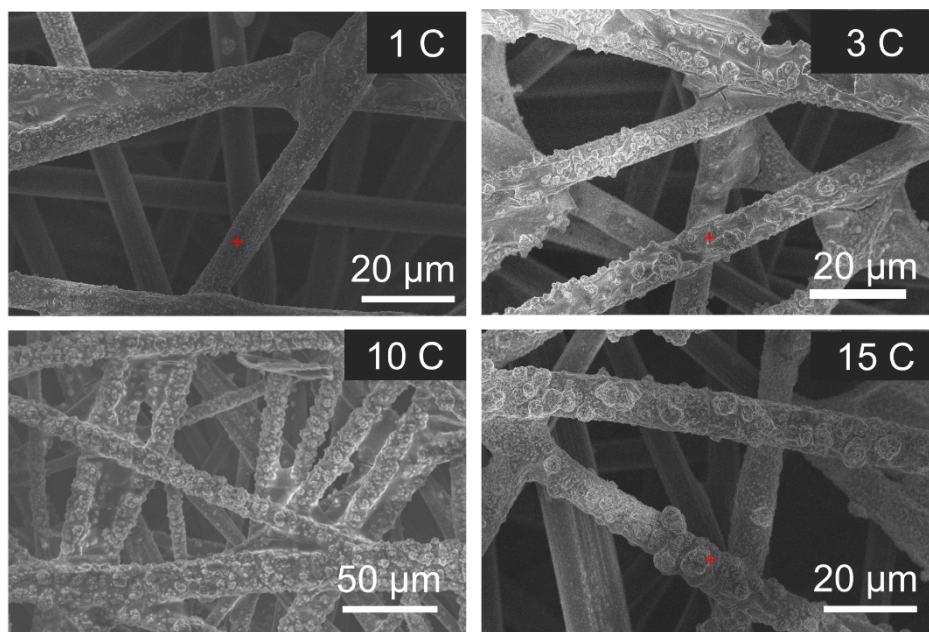


Fig. S1. LSV of the deposition solution, KCN solution containing CuSO<sub>4</sub> and AgNO<sub>3</sub> as a function of applied potential.



**Fig. S2.** Samples of the deposited Cu<sub>2</sub>O-Ag catalyst upon applying 0.18 V<sub>RHE</sub> under various conditions. (a) XRD patterns depending on temperature. (b) XRD patterns of the deposited catalysts depending on the applied voltage at room temperature (25°C).



**Fig. S3.** SEM images of the Cu<sub>2</sub>O-Ag placed on a carbon paper deposited applying for various charge (1 C, 3 C, 10 C, and 15 C).

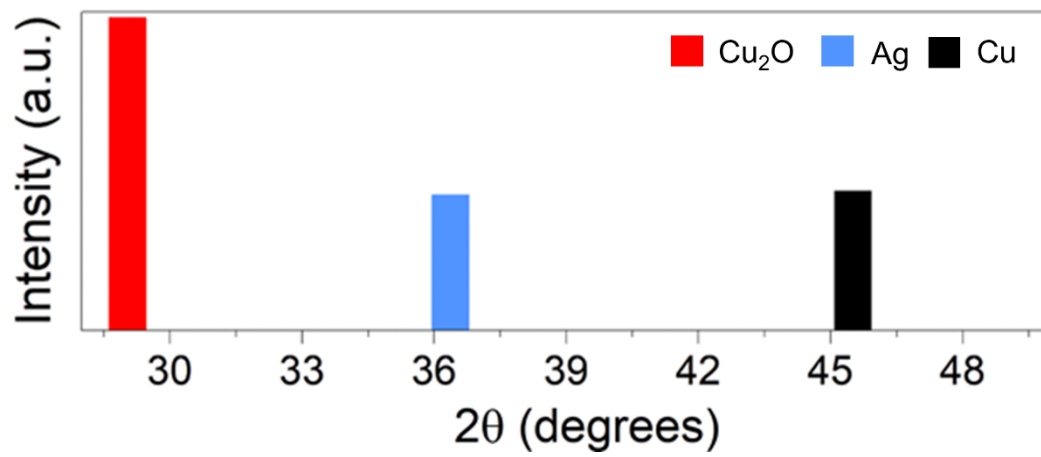
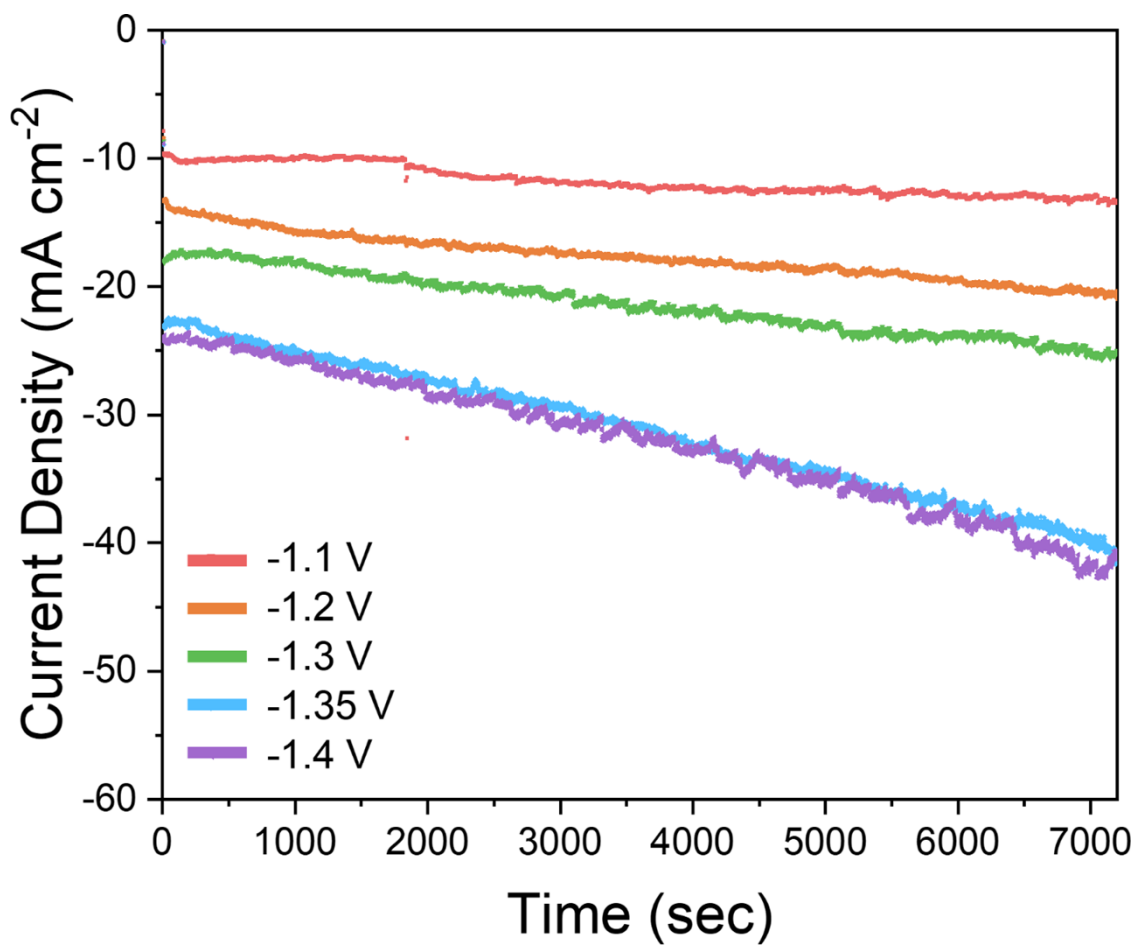
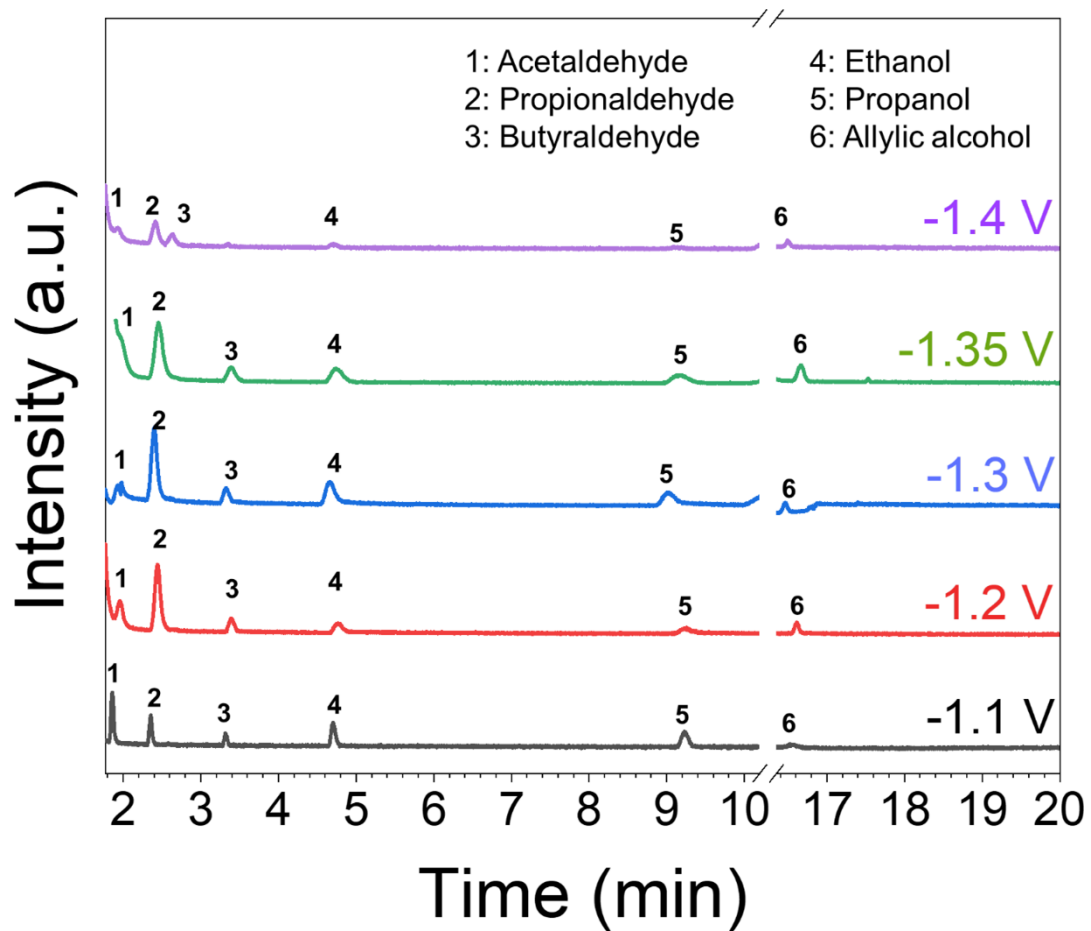


Fig. S4. SAED pattern converted to an XRD pattern of as-prepared Cu<sub>2</sub>O-Ag.

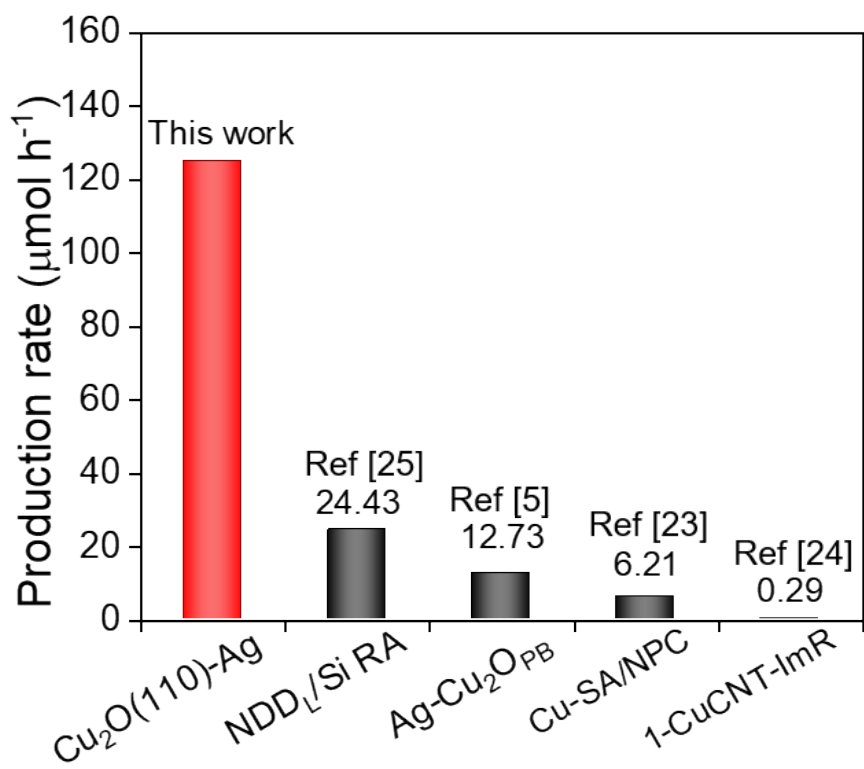




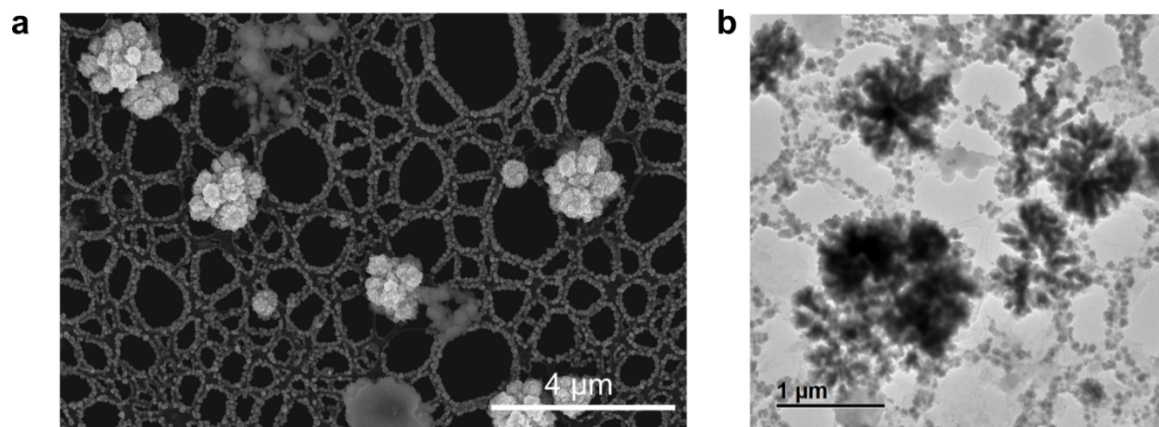
**Fig. S5.** Current density-time profile of the Cu<sub>2</sub>O-Ag electrode applying different cathode potentials for 2 hr. (Electrolyte: 0.5 M KHCO<sub>3</sub>, temperature: 25°C)



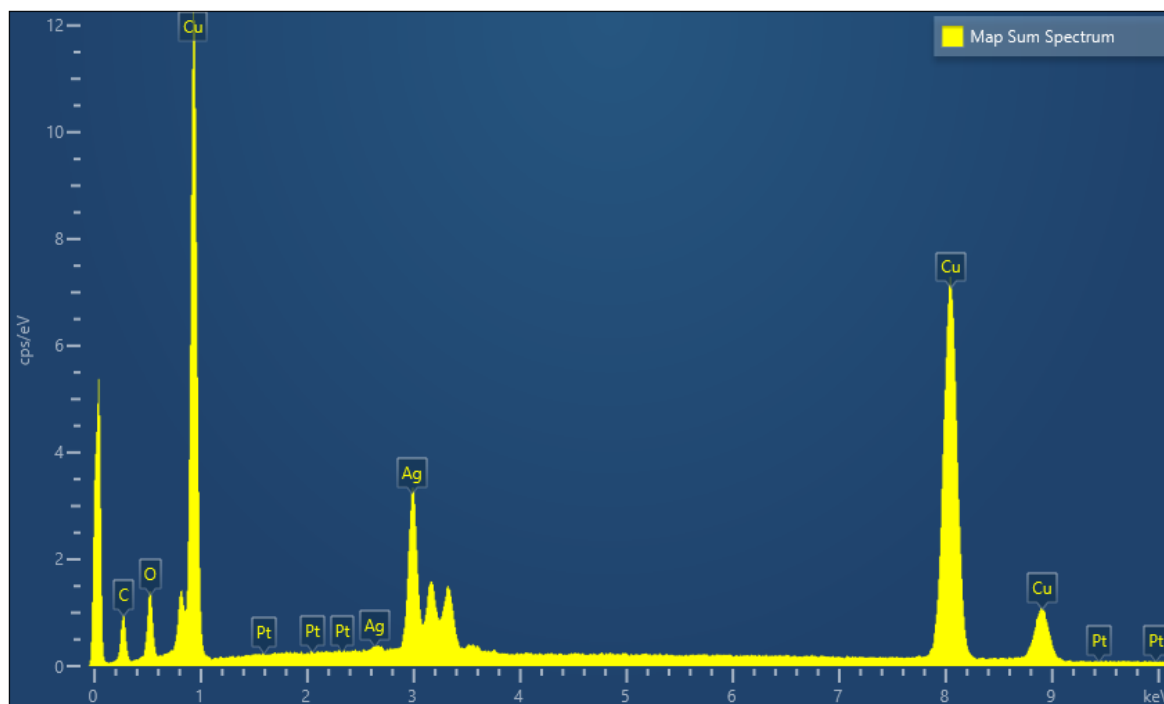
**Fig. S6.** HS-GC-MS total ion chromatogram of the catholyte samples after the CO<sub>2</sub>RR for 2 hr depending on the applied potentials. (Electrolyte: 0.5 M KHCO<sub>3</sub>, temperature: 25°C)



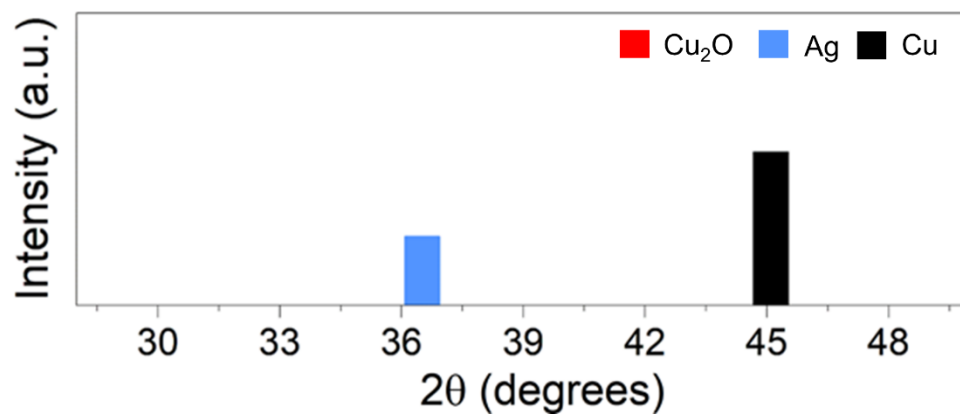
**Fig. S7.** Comparison of the liquid  $\text{C}_{2+}$  production rate of the relocated  $\text{Cu}_2\text{O-Ag}$  catalyst and other studies using Cu-based catalysts. (The experimental details are represented in Table S2 in the Supporting Information, Refs. 5, 23-25)



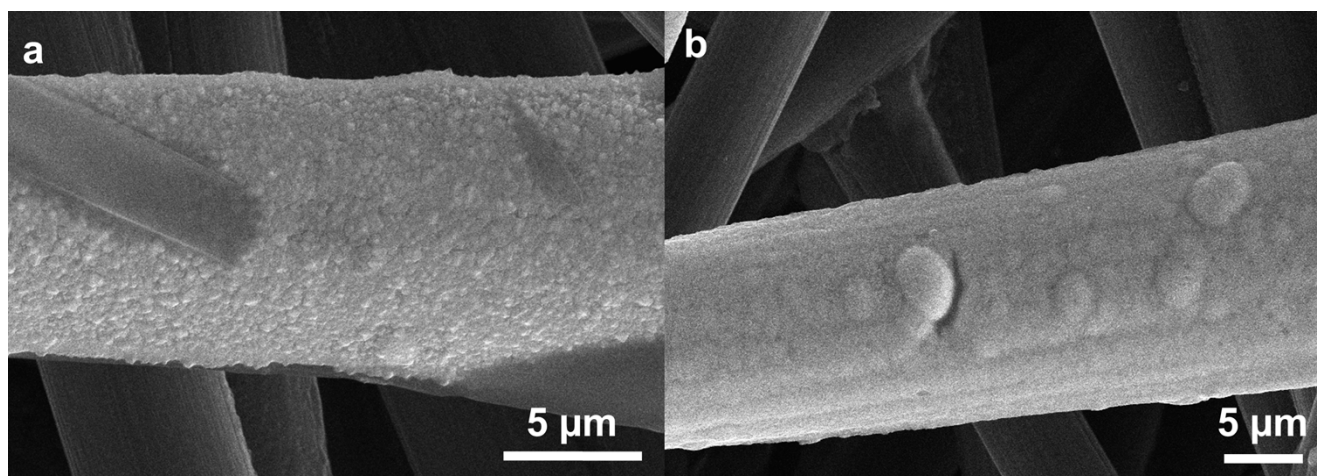
**Fig. S8.** (a) SEM and (b) TEM images of the relocated Cu(111)-Ag catalyst placed on a TEM grid after the CO<sub>2</sub>RR. Applied cathode potential: -1.3 V<sub>RHE</sub> for 2 hr.



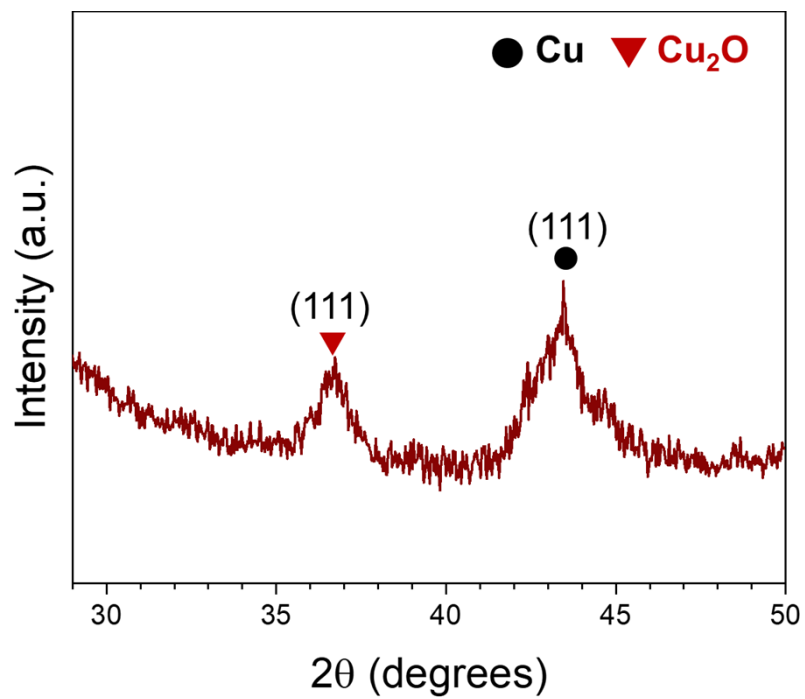
**Fig. S9.** SEM-EDS analysis of relocated Cu(111)-Ag after the CO<sub>2</sub>RR experiment for 2 hr at -1.3 V<sub>RHE</sub>.



**Fig. S10.** SAED pattern converted to an XRD pattern of relocated Cu(111)-Ag after the CO<sub>2</sub>RR.

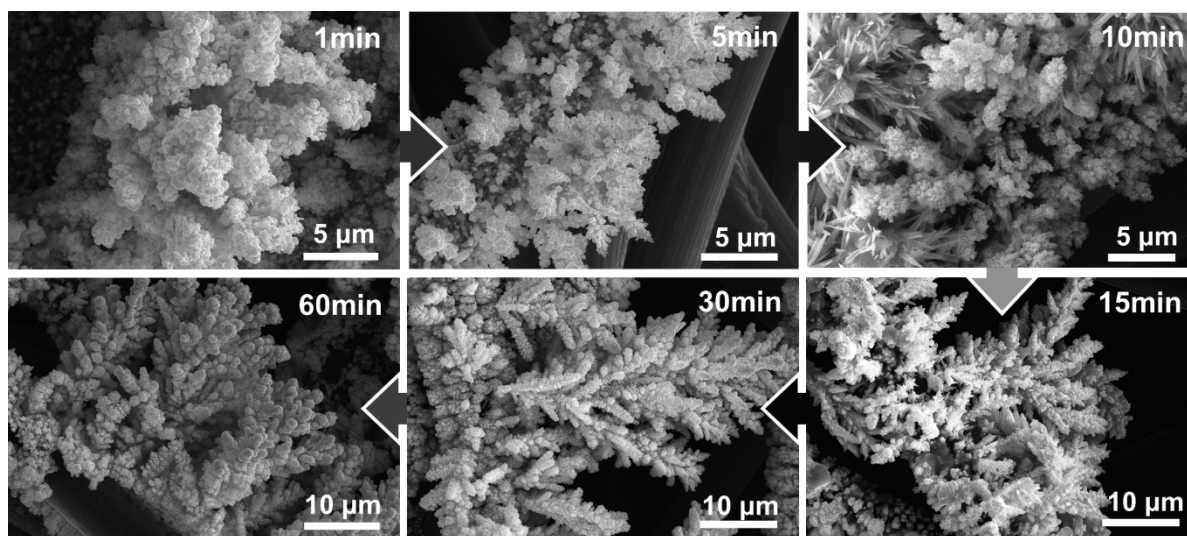


**Fig. S11.** SEM images of Cu electrode a) before and b) after 120 min of reaction under  $-1.3 V_{\text{RHE}}$  with  $\text{CO}_2$  gas purging.

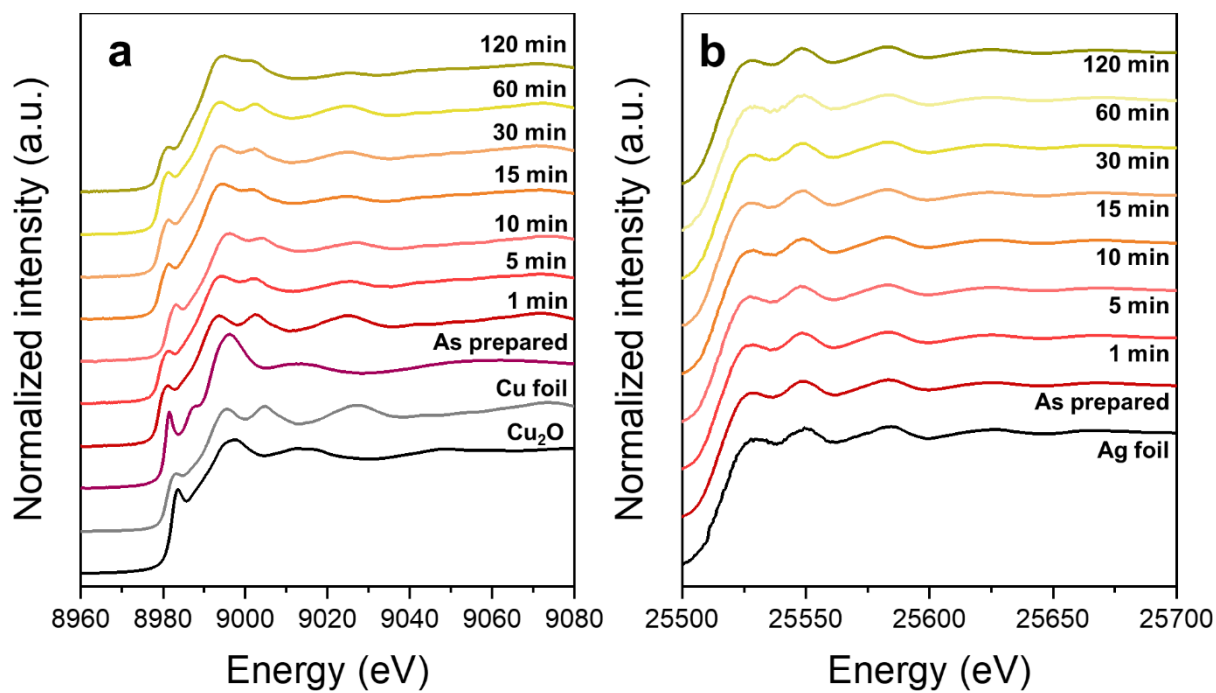


**Fig. S12.** XRD pattern of electrodeposited only Cu<sub>2</sub>O catalyst sample (at 0.182 V<sub>RHE</sub>, for 10 C, at 25°C)

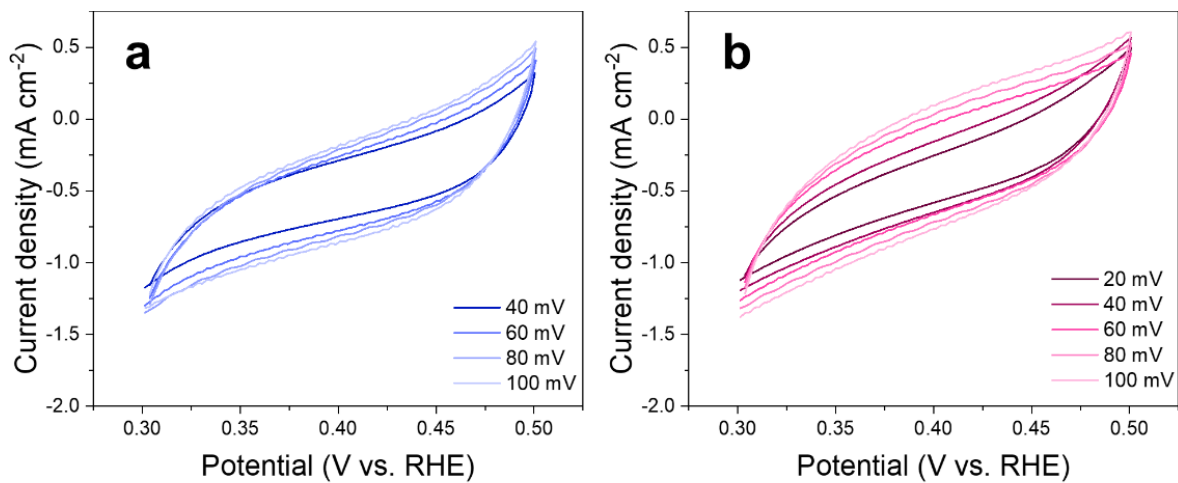




**Fig. S13.** (a) SEM images of relocated Cu(111)-Ag catalyst samples depending on the CO<sub>2</sub> reduction reaction time of 1 min, 5 min, 10 min, 15 min, 30 min, 60 min applying -1.3 V<sub>RHE</sub> with CO<sub>2</sub> gas purging.



**Fig. S14.** Normalized **a** Cu and **b** Ag K-edge XANES spectra of Cu<sub>2</sub>O-Ag in as-prepared state and after 1, 5, 10, 15, 30, 60, and 120 min CO<sub>2</sub>RR at -1.3 V<sub>RHE</sub>.



**Fig. S15.** Cyclic voltammetry taken over a range of scan rates to measure double-layer capacitances of Cu<sub>2</sub>O-Ag electrodes. (a) before and (b) after the CO<sub>2</sub>RR in 0.5 M KHCO<sub>3</sub>.