

Electronic Supplementary Information

One-Step Separation and Recovery of Copper and Sulfur by Electrolysis in Deep Eutectic Solvents

Jihua Li,^a Yucheng Xu,^a Jinfeng Zhou,^a Weijia Chen,^a Shiwei He,^{a,b*} Zhongsheng Hua,^{a,b} Hui Kong^{a,c*}

^a. School of Metallurgical Engineering, Anhui University of Technology, Maanshan 243002, China

^b. Wuhu Technology and Innovation Research Institute, AHUT, Wuhu 241000, China

^c. Anhui International Joint Research Center for Metallurgical Process and System Science, Maanshan 243002, China

*Corresponding Authors:

E-mail: heshiweiahut@163.com;

konghui@ahut.edu.cn

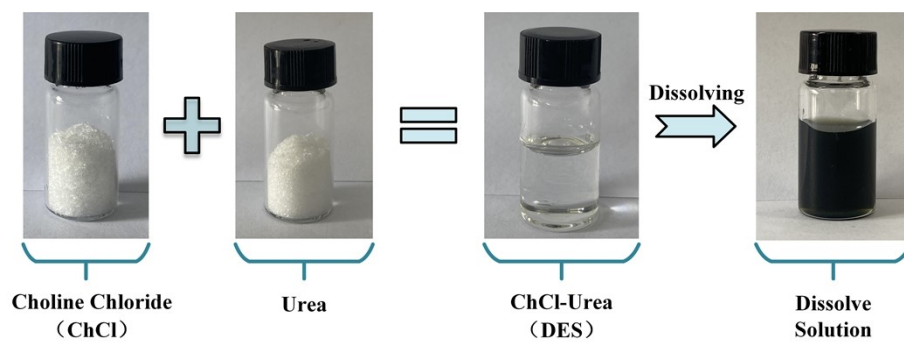


Fig. S1 Schematic diagram of dissolution of Cu_2S in Reline DES.

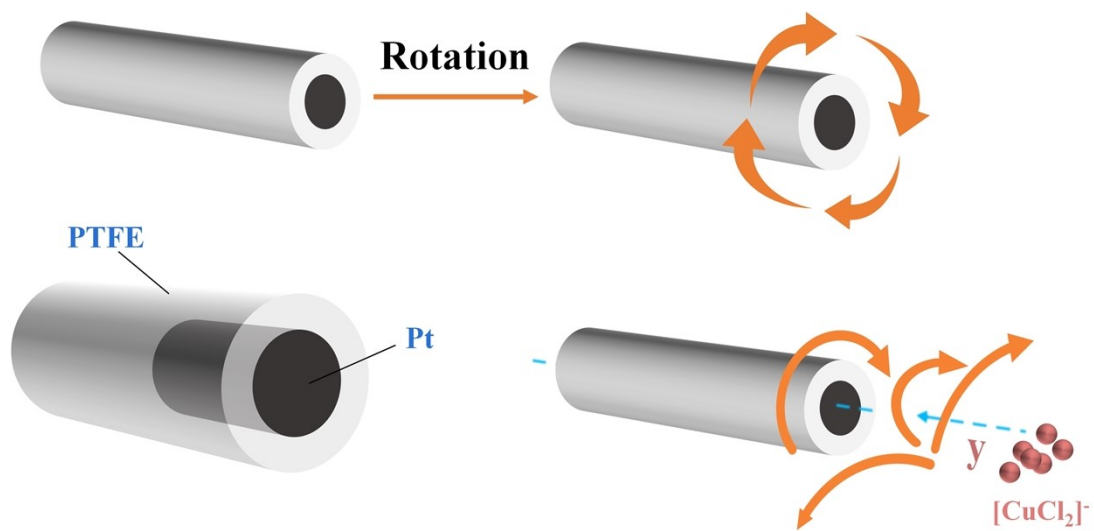


Fig. S2 Schematic diagram of rotating disc electrode (RDE)

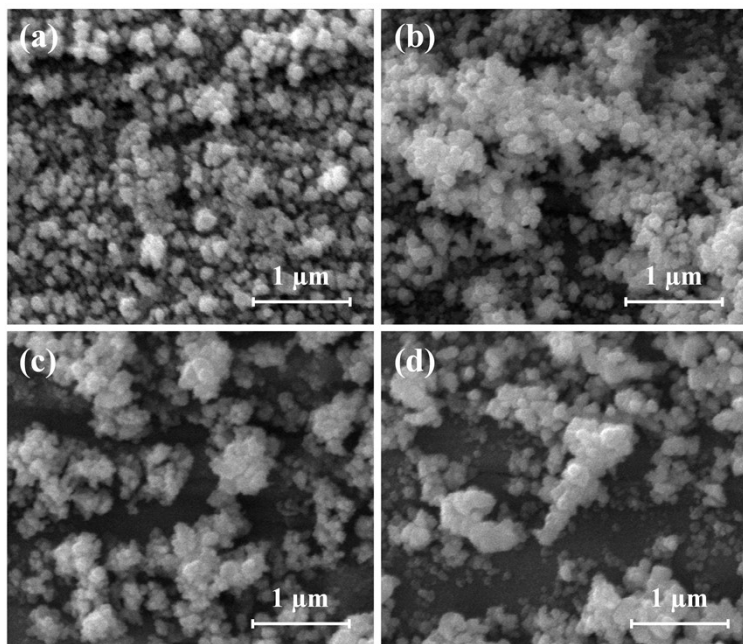


Fig. S3 The SEM micrographs of the cathodic products after electrolysis at different temperatures in Reline-Cu₂S (electrolysis voltage: 1.2 V; electrolysis time: 6 h): (a) 75 °C; (b) 80 °C; (c) 85 °C; (d) 90 °C.

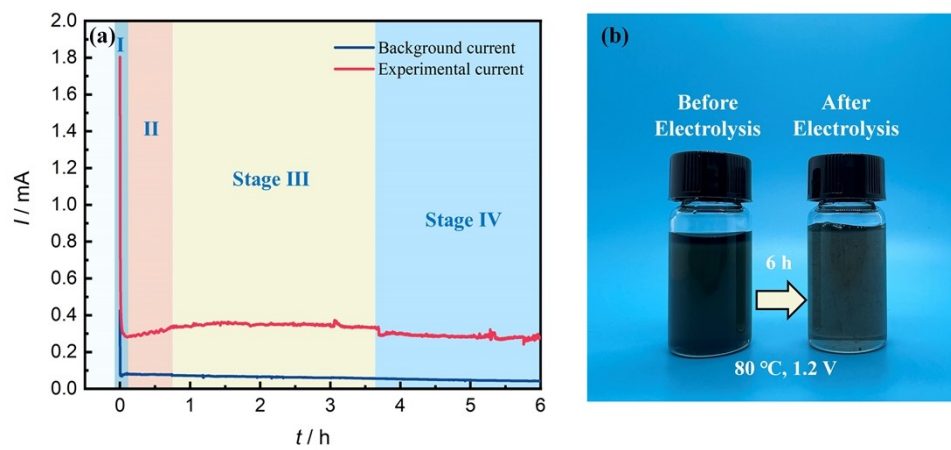


Fig. S4 (a) Variations of cathodic current with electrodeposition time in Reline-Cu₂S at 80 °C for 6h. (b) Color change of electrode before and after electrolysis.

Table S1 Chemical reagents for experiments

| Name | Molecular Formula | Molecular Weight | Purity | Manufacturer |
|------------------|-------------------|------------------|-------------|--------------|
| Choline Chloride | $C_5H_{14}ClNO$ | 139.63 | $\geq 98\%$ | Macklin |
| Urea | CH_4N_2O | 60.06 | $\geq 99\%$ | Macklin |
| Cuprous Sulfide | Cu_2S | 159.16 | $\geq 99\%$ | Macklin |

Table S2 Experimental instruments and equipment

| Instrument Name | Model | Manufacturer |
|---|--------------------------------------|--|
| Rotating Disk Electrode | RRDE | Taizhou Keruite Analytical Instrument Co., Ltd. |
| Viscosimeter | NDJ-9S | Shanghai Lichen Bangxi Instrument Technology Co., Ltd. |
| Bench Grinder | MQD3215-C | Jiangsu Jinding Electric Tools Group Co., Ltd. |
| Electronic Balance | LC-FA2204 | Shanghai Lichen Bangxi Instrument Technology Co., Ltd. |
| Constant Temperature Magnetic Stirrer | LC-MSH-Pro | Shanghai Lichen Bangxi Instrument Technology Co., Ltd. |
| Digital Thermostatic Water Bath | HH-1 | Changzhou Guohua Electric Appliances Co., Ltd. |
| Constant Current Source | HLR-7530D | Guangdong Henghuiyuan Electronics Co., Ltd. |
| Electrochemical Workstation | PARSTAT2273 | Princeton Applied Research |
| Electrochemical Workstation | CHI760E | Shanghai Lichen Bangxi Instrument Technology Co., Ltd. |
| Air Blast Drying Box | Dhg-9023a | Shanghai Yiheng Technology Instrument Co., Ltd. |
| Fourier Transform Infrared Spectroscopy | Nicolet Is 10 | ThermoFisher Scientific |
| Electrospray Ionisation Mass Spectrometry | Thermo Scientific Q Exactive | ThermoFisher Scientific |
| Scanning Electron Microscopy Energy Dispersive Spectrometer | Navo Nanosem450 Azteccone X-Max20 | FEI (ThermoFisher Scientific) Oxford Instruments |
| X-Ray Diffractometer | Rigaku D/Max-2550 | Rigaku Corporation |
| X-Ray Photoelectron Spectrometer | Thermo Nexsa | ThermoFisher Scientific |

Table S3 The yield, purity, and mass of the isolated products after 12 hours of electrolysis with 1.592g Cu₂S dissolved in ChCl-TU DES (Cu₂S concentration: 0.02 mol/L)

| Product | Yield | Purity | Mass |
|---------------------|--------|-----------|--------|
| Cathodic product Cu | 21.29% | 99.37 wt% | 272 mg |
| Anodic product S | 20.50% | 97.51 wt% | 65 mg |