# Supplementary Information

# One-step hydrothermal preparation of $WO_3$-carbon felt for electrolytic recovery of copper from PCB wastewater

**Text S1** Determination of COD

According to the HJ/T 399–2007 standard, the chemical oxygen demand (COD) of water samples was determined using the rapid digestion–spectrophotometric method. A silver sulfate–sulfuric acid solution was prepared by adding 5.0 g of silver sulfate to 500 mL of sulfuric acid (1.84 g $mL^{-1}$) and stirring thoroughly. In a digestion tube, 1.00 mL of potassium dichromate solution (0.0833 mol $L^{-1}$), 0.50 mL of mercury sulfate solution (0.24 g $mL^{-1}$), and 6.00 mL of the prepared silver sulfate–sulfuric acid solution were sequentially added. The mixture was homogenized and stored at room temperature in the dark as a pre-mixed reagent. Subsequently, 2.00 mL of the pre-mixed reagent was added to each sample and blank, homogenized, and placed in a DRB200 digestion apparatus preheated to 165 °C for 15 min. After digestion, the tubes were allowed to cool to approximately 60 °C. The tubes were inverted several times while holding the caps to ensure uniform distribution of the contents, and the outer surfaces were wiped with lint-free paper. After cooling to room temperature, the absorbance was measured at 600 ± 20 nm using water as the reference solution with a spectrophotometer. The COD concentration was calculated from the calibration curve.

**Text S2** Simulated copper-containing wastewater formulation

The simulated wastewater was prepared based on the typical composition of actual

PCB wastewater. The formulation included copper sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) at a dosage of 19,531 mg/L (equivalent to 5000 mg/L of $Cu^{2+}$), concentrated sulfuric acid (98% $H_2SO_4$) at 10 mL/L (resulting in a pH of approximately 0.7), glucose at 937 mg/L (corresponding to a COD of 1000 mg/L), and ammonium sulfate ($(NH_4)_2SO_4$) at 94.34 mg/L (providing 20 mg/L of $NH_4^+$-N).

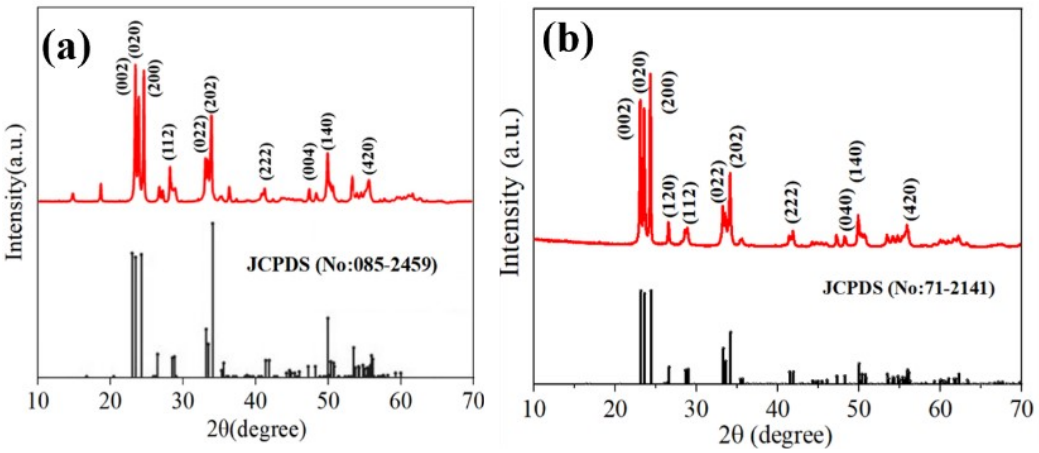


**Figure S1.** XRD spectra of (a) $WO_3$ powder and (b) $WO_3$–carbon felt electrode.

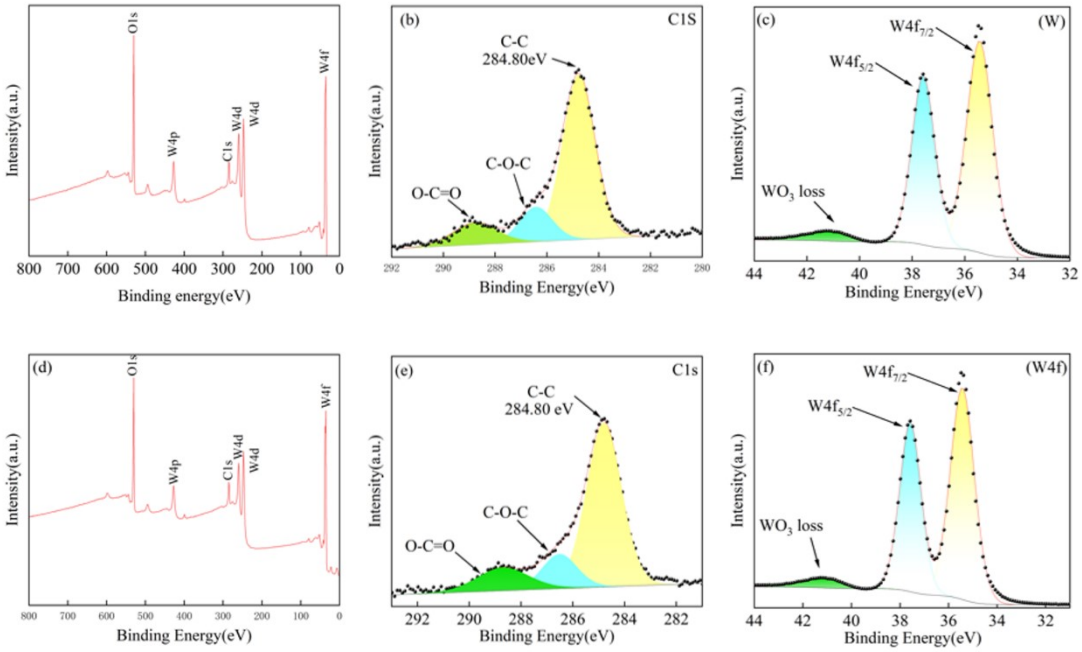


**Figure S2** XPS spectra of (a-c) WO3 powder and (d-f) WO3–carbon felt electrode.

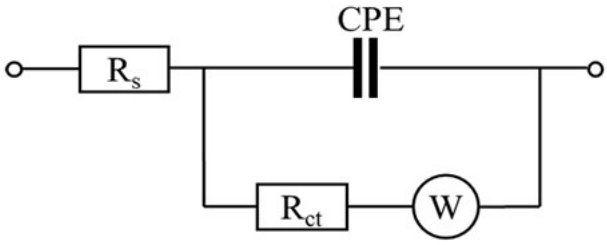


**Figure S3** Equivalent circuit diagram for EIS testing.

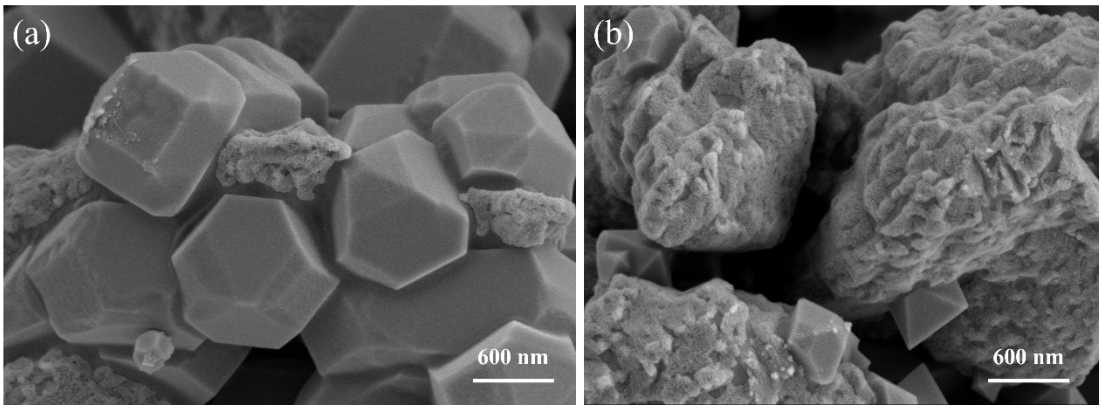


**Figure S4** SEM images of copper recovered.