

Supporting Information

Unconventional 0-, 1-, and 2-Dimensional Single-Crystalline Copper Sulfide Nanostructures

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Experimental Section

Materials and characterization: All chemicals used in this work were analytical reagent grade and commercially available, and used without further purification. Copper(II) chloride dihydrate ($\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$) and sulfur were purchased from Sinopharm Chemical Reagent Co., Ltd., China. Single-crystal Si wafers (<100>, University Wafer Co., USA) covered with 500 nm thermal SiO_2 were cleaned prior to use by washing with ethanol, and subsequently dried in air. Field-emission scanning electron microscopy (SEM) characterization was carried out on a S-4800 field-emission SEM (Hitachi, Japan). Transmission electron microscopy (TEM) images were taken with a JEM-2100F field-emission TEM at an acceleration voltage of 200 kV (Jeol, Japan). X-ray diffraction (XRD) data were collected on a X-ray single crystal diffractometer (Bruker SMART APEX (II)-CCD, Germany) with $\text{Cu-K}\alpha$ radiation ($\lambda = 1.5418 \text{ \AA}$) and 2θ ranging from $20\text{--}60^\circ$. The UV-vis absorption spectrum was measured using a PG2000 Pro UV-vis spectrometer (Idea Optics Co., Ltd, China). The X-ray photoelectron spectroscopy (XPS) spectra were recorded on a Rigaku XPS 7000 spectrometer using non-monochromatic Mg K (alpha) (1253.6 eV) at a source of 200 W.

Preparation of copper sulfide: Copper sulfides were synthesized in a home-built CVD reactor comprised of a 1-inch fused silica tube placed in a single-zone tube furnace (Lindberg Blue M, USA). The sealed tube is equipped with pressure and multiple-gas flow controllers, and a liquid nitrogen trap downstream before the vacuum pump. The base pressure is ~ 0.1 Torr. In a typical growth, a porcelain boat containing 30 mg of $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ was placed inside the quartz tube at the center of the furnace, and a second porcelain boat containing 50 mg of sulfur was

placed upstream just outside the mouth of the furnace ceramic insulation. Several 5-mm wide, strip-shaped Si/SiO₂ substrates were placed downstream at different distances from the boat containing CuCl₂·2H₂O. The quartz tube was evacuated and flushed 3 times with argon and then heated to 150 °C to remove water content of the CuCl₂·2H₂O. The temperature was then increased to 550 °C and a pressure of 1.5 atm, with a heating rate of 20 °C/min under 150 sccm of Ar. Once the target temperature was reached, the sulfur boat was inserted just inside the mouth of the furnace, with 100 sccm H₂ co-flowing for 5 min. After that, hydrogen flow was shut off while keeping the Ar flow. The reaction was continued for another 10 min, before complete pumping and cooling down to room temperature.

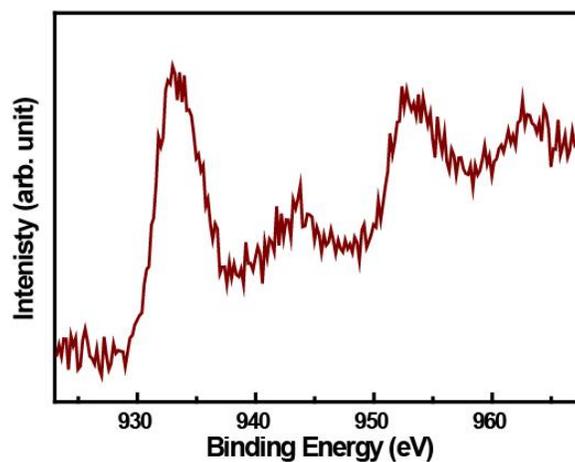


Figure S1. XPS spectra showing the Cu 2p peaks of the copper sulfide nanocrystals.

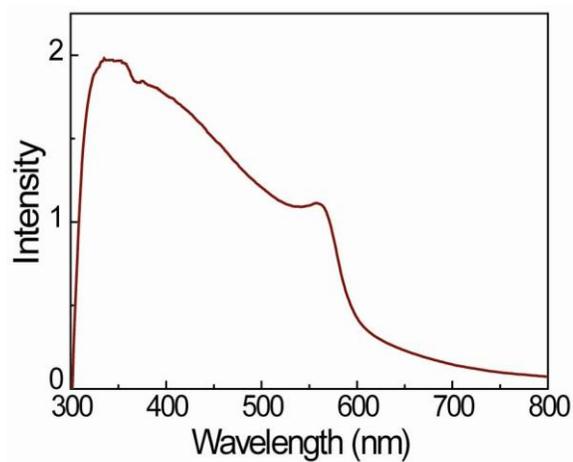


Figure S2. UV-vis spectra of the copper sulfide nanocrystals.

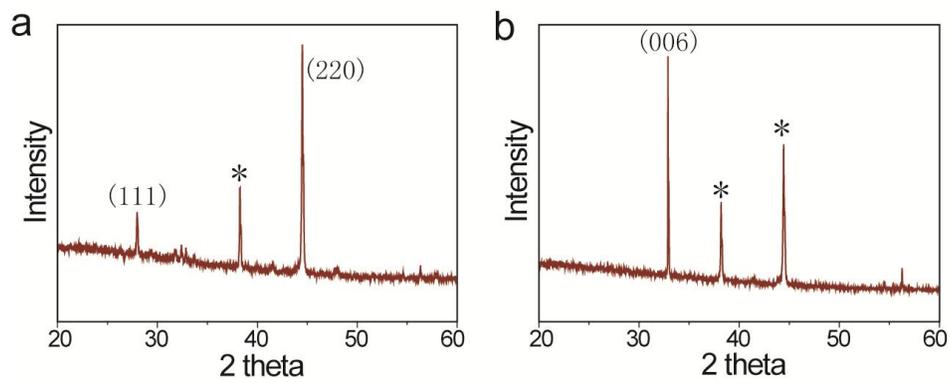


Figure S3. XRD patterns of copper sulfide (a) nanorods and (b) nanoflakes.

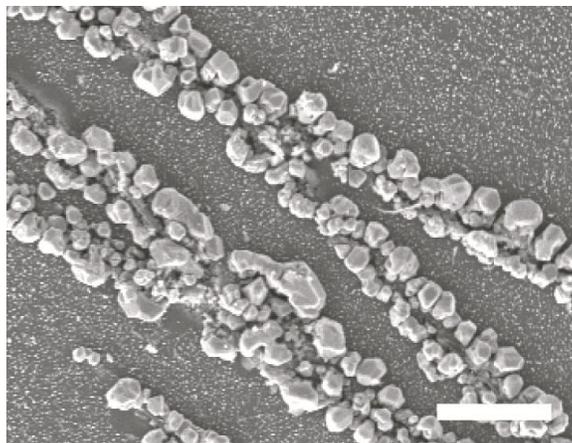


Figure S4. SEM image of micron-sized copper sulfide crystals. Scale bar represents 5 μm.