Electronic supplementary information

Seed-mediated synthesis of polyhedral 50-facet Cu$_2$O architectures

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Synthesis of cubic Cu$_2$O seeds: In a typical synthesis, 0.9982 g of Cu(CH$_3$COO)$_2$ was dissolved in deionized water (100 mL) using a beaker under a constant stirring at 70 °C for 2 min. A dark precipitate was produced when a sodium hydroxide solution (6 M, 5 mL) was added dropwise to the above solution. After being stirred for 5 min, D-(+)-glucose powder (0.2 g) was added into the dark precursor with a constant stirring for another 60 min at 70 °C, and then was allowed to cool to room temperature naturally. Afterward, the obtained products were centrifuged at 5000 rpm for 1 min (XIANYI TG16-WS centrifuge). The precipitates were centrifuged twice more in deionized water and anhydrous ethanol, respectively. And finally were dried at 70 °C for 12 hours in a vacuum oven.

Synthesis of 14-facet Cu$_2$O crystals: In a typical synthesis, 2.9946 g of Cu(CH$_3$COO)$_2$ was dissolved in deionized water (20 mL) using a beaker, and then 0.10 g of cubic Cu$_2$O powder was added into the solution under a constant stirring at 70 °C for 2 min. A dark precipitate was produced when a sodium hydroxide solution (9 M, 10 mL) was added dropwise to the above solution. After being stirred for 5 min, D-(+)-glucose powder (0.3 g) was added into the dark precursor with a constant stirring for another 25 min at 70 °C, and then was allowed to cool to room temperature naturally. The precipitates were centrifuged twice more in deionized water and anhydrous
ethanol, respectively. And finally they were dried at 70 °C for 12 hours in a vacuum oven.

**Synthesis of octahedral Cu$_2$O seeds:** In a typical synthesis, 2.9946 g of Cu(CH$_3$COO)$_2$ was dissolved in deionized water (20 mL) using a beaker under a constant stirring at 70 °C for 2 min. A dark precipitate was produced when a sodium hydroxide solution (9 M, 10 mL) was added dropwise to the above solution. After being stirred for 5 min, D-(+)-glucose powder (0.3 g) was added into the dark precursor with a constant stirring for another 60 min at 70 °C, and then was allowed to cool to room temperature naturally. Afterward, the obtained products were centrifuged at 5000 rpm for 1 min (XIANYI TG16-WS centrifuge). The precipitates were centrifuged twice more in deionized water and anhydrous ethanol, respectively. And finally were dried at 70 °C for 12 hours in a vacuum oven.

**Synthesis of polyhedral M-pyramid Cu$_2$O architecture via octahedral Cu$_2$O seeds:** In a typical synthesis, 0.9982 g of Cu(CH$_3$COO)$_2$ was dissolved in deionized water (100 mL) using a beaker, and then 0.10 g of octahedral Cu$_2$O powder (SEM image are shown in Fig. 3a) were added into the solution under a constant stirring at 70 °C for 2 min. A dark precipitate was produced when a sodium hydroxide solution (6 M, 5 mL) was added dropwise to the above solution. After being stirred for 5 min, D-(+)-glucose powder (0.2 g) was added into the dark precursor with a constant stirring for another 3 min at 70 °C, and then was allowed to cool to room temperature naturally. Afterward, the obtained products were centrifuged at 5000 rpm for 1 min (XIANYI TG16-WS centrifuge). The precipitates were centrifuged twice more in deionized water and anhydrous ethanol, respectively. And finally were dried at 70 °C for 12 hours in a vacuum oven.

The crystal phase of as-prepared products was characterized by an X-ray diffractometer Bruker-AXS D8 ADVANCE) using Cu Kα radiation (λ = 1.54 Å) in the range (20 ~ 80 °). The morphology of the products was investigated by field-emission scanning electron microscopy (FE-SEM) using JEOL (JSM-7000F) at an accelerating voltage of 20 KV.

**Photocatalytic property**
The catalytic activity experiments of the different kinds of Cu$_2$O (including the as-prepared 50-facet and 14-facet Cu$_2$O crystals) for the oxidation and decoloration of the methyl orange (MO) dye were carried out at ambient temperature. The original solution was prepared by adding 50 mL MO solution (5 mg/L), and then 0.1 g Cu$_2$O powder was added into the solution to form the aqueous dispersion. Before illumination, the solution was vigorously stirred in the dark for 0.5 h to evaluate the adsorption property. Afterwards, the dispersion was irradiated by a 500 W xenon lamp equipped with a filter cutoff ($\lambda \geq 420$ nm) under magnetic stirring. At given time intervals, the dispersion was sampled and centrifuged to separate the catalyst. UV-vis absorption spectra were recorded at different intervals to monitor the reaction using a UV/vis/NIR spectrophotometer (Hitachi U-4100).

**Fig. S1** (a) FESEM image and (b) XRD pattern of the cubic Cu$_2$O seeds.

**Fig. S2** The crystallographic structures of {100} (a) and {111} (b) facets of Cu$_2$O crystal.