Facile Fabrication of Cu(OH)$_2$ and CuO Nanoribbon Arrays by Silver-Mediated Oxidation

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Experiment section

Materials

AgNO₃, Na₂O₂ and HCl were obtained from Chengdu Chemical Reagent Factory (Chengdu, China). High purity copper foils (Cu, 99.999%) were from Shanghai Chemical Reagent Co. (Shanghai, China). All reactants were analytical pure and used without further purification. Doubly distilled water was used throughout the experiment.

Instruments and Characterization

The size and morphology of the nanostructures were characterized by a Hitachi S-4800 field-emission scanning electron microscope (Tokyo, Japan). TEM measurements were conducted on a Hitachi-H800 transmission electron microscope (Tokyo, Japan) operating at 200 kV. HRTEM and ED were performed on a Tecnai G2 F20 FE-TEM (FEI, The Netherlands). The composition of the as-prepared sample grew on the copper was examined by X-ray powder diffraction (XRD), performed using a DX-1000 powder X-ray diffractometer (Dandong Fangyuan Instrument Co., Dandong, China) with graphite monochromatized Cu Ka radiation (λ = 1.54178Å). The resistance of the copper foil during reaction was measured in situ with a FLUKE 8846A digital multimeter (Fluke, USA) using Pt wire counter electrode and Cu foil working electrode.

Preparation of Cu(OH)₂ and CuO nanoribbon arrays

Copper foils (4cm*1cm) were carefully polished with abrasive papers, then immersed into 4M HCl for 30s to remove the copper oxide, and washed with double distilled water several times, then quickly put into a 30 ml beakers with freshly prepared 10 ml 0.4M Na₂O₂ aqueous solution, and 10 ml AgNO₃ aqueous solution (0.6, 6, and 15mM respectively) was immediately poured into at ambient conditions without stirring. The copper foils were took out of the solution at 2min, 5 min, and 40min respectively, then washed with doubly distilled water several times and dried in air for further characterization. Under ultrasonication, CuO nanoribbon array on copper substrate was fabricated under the same experimental condition as Cu(OH)₂ nanoribbons.
Fig. S1 (A) SEM image. (B) XRD pattern of the as-prepared Ag nanoparticles at a scan rate of 0.08°/sec of 2θ range from 20 to 80°. (C) TEM and (D) HRTEM images of the Ag nanoparticles from a mixture solution containing 0.2M Na₂O₂ and 3mM AgNO₃.
**Fig. S2** The XRD pattern of the Cu(OH)$_2$ nanoribbons modified copper foil at a scan rate of 0.06°/sec of 2θ range from 10 to 70°.
Fig. S3 (A) Low and (B) high magnification SEM images of the copper foil in 20ml 0.2M Na₂O₂ solution reacting for 6 hours without the addition of AgNO₃.
Fig. S4 The resistance of copper foil in the Na$_2$O$_2$ solution and the mixed solution containing AgNO$_3$ and Na$_2$O$_2$. The resistance of the copper foil in Na$_2$O$_2$ solution increased remarkably immediately after the addition of AgNO$_3$ solution indicating the growing of the Cu(OH)$_2$ nanoribbons, and increased dramatically after about 5 min due to the formation of uniform Cu(OH)$_2$ nanoribbon array. That’s is to say, the etching of copper surface and the growth of the Cu(OH)$_2$ nanoribbons progressed in the presence of AgNO$_3$. 
Fig. S5 XRD of CuO nanoribbon array fabricated in the mixture solution containing 0.2M Na₂O₂ and 3mM AgNO₃ under ultrasonic irradiation at a scan rate of 0.06°/sec for 20 range from 20 to 80°.