

Synthesis of Self-Supported Cu/Cu₃P Nanoarrays as an Efficient Electrocatalyst for the Hydrogen Evolution Reaction

Rui Dang ^{1,*}, Xiufeng Xu ², Mengmeng Xie ² and Jian Liu ^{2,*}

¹ Northwest Institute For Nonferrous Metal Research, 96 Weiyang Road, Weiyang District, Xi'an 710016, China

² The Faculty of Printing, Packaging Engineering and Digital Media Technology, Xi'an University of Technology, Xi'an 710048, China; xfengalone@163.com (X.X.); xiemeng1216@163.com (M.X.)

* Correspondence: dr0501@163.com (R.D.); liujian@xaut.edu.cn (J.L.)

Abstract: Owing to the energy crisis and environmental pollution, it is essential to develop cheap, environmentally friendly and sustainable energy to replace noble metal electrocatalysts for use in the hydrogen evolution reaction (HER). We report herein that a Cu/Cu₃P nanoarray catalyst was directly grown on the surfaces of Cu nanosheets from its Cu/CuO nanoarray precursor by a low-temperature phosphidation process. In particular, the effects of phosphating distance, mass ratio and temperature on the morphology of Cu/Cu₃P nanoarrays were studied in detail. This nanoarray, as an electrocatalyst, displays excellent catalytic performance and long-term stability in an acid solution for electrochemical hydrogen generation. Specifically, the Cu/Cu₃P nanoarray-270 exhibits a low onset overpotential (96 mV) and a small Tafel slope (131 mV dec⁻¹).

Keywords: Cu/Cu₃P nanoarrays; Cu nano-substrates; electrocatalyst; HER

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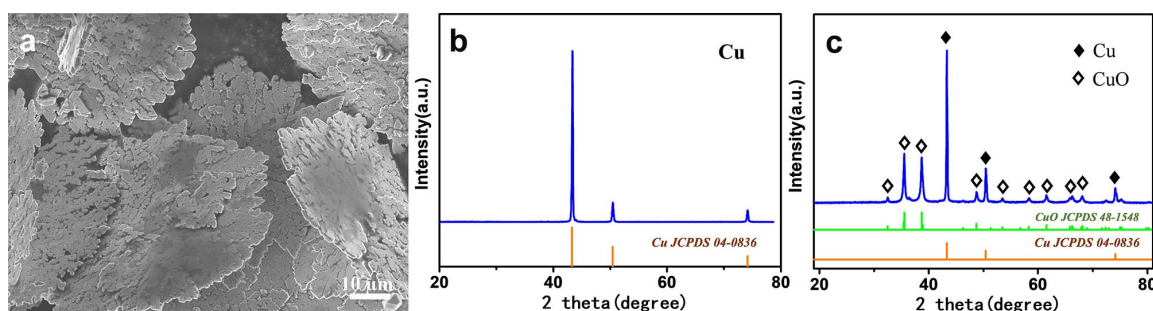


Figure S1. Characterization of the morphology and structure of samples: (a) SEM image of Cu nanosheet, (b) XRD patterns of Cu nanosheets, and (c) XRD patterns of Cu/CuO nanoarrays.

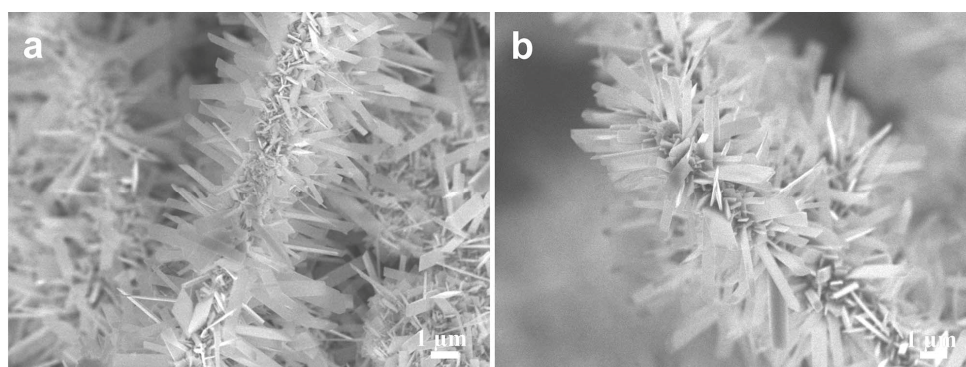


Figure S2. The high magnification SEM images of samples : (a,b) SEM image of Cu/CuO nanoarrays.

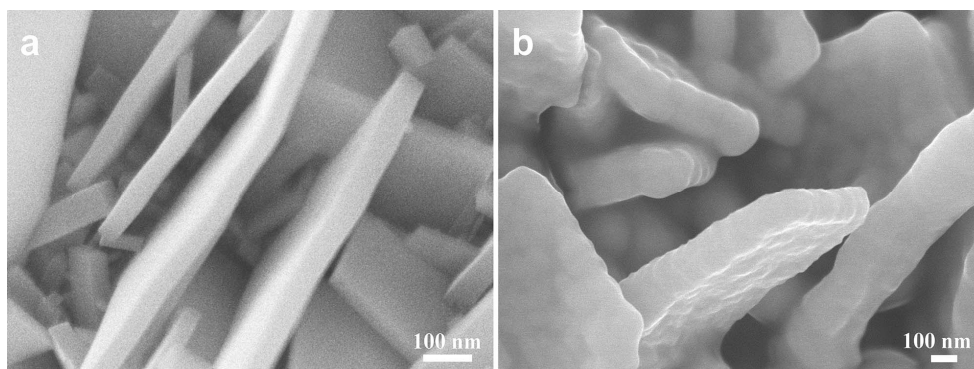


Figure S3. The high magnification SEM image of (a) CuO nanoplate, (b) Cu₃P nanoplate.

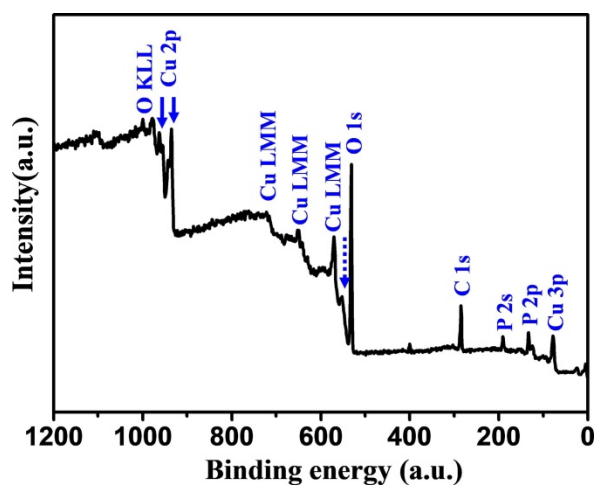


Figure S4. XPS survey spectrum of Cu /Cu₃P nanoarrays.

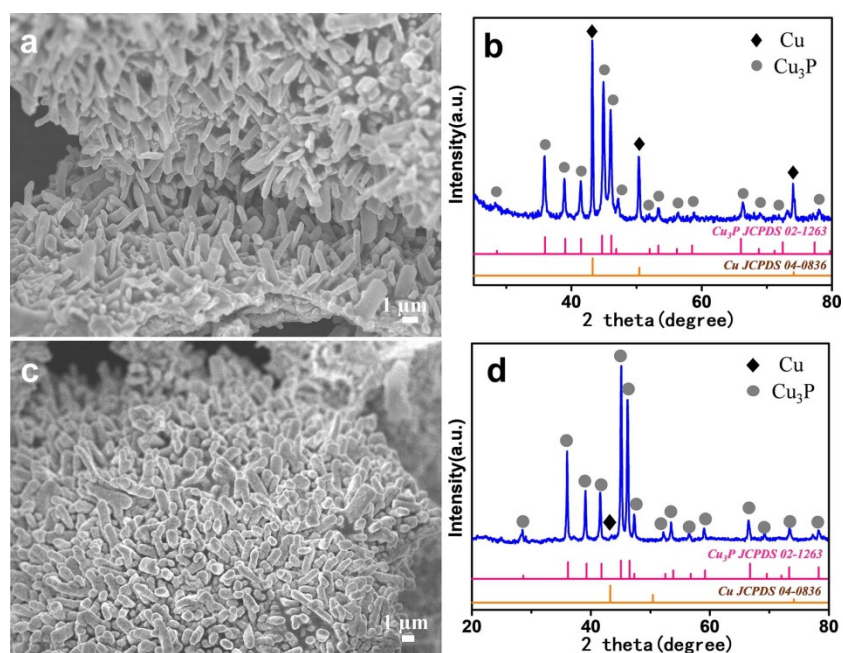


Figure S5. The SEM images and XRD patterns of sample at different phosphating time: (a,b) 1h; (c,d) 1.5h.

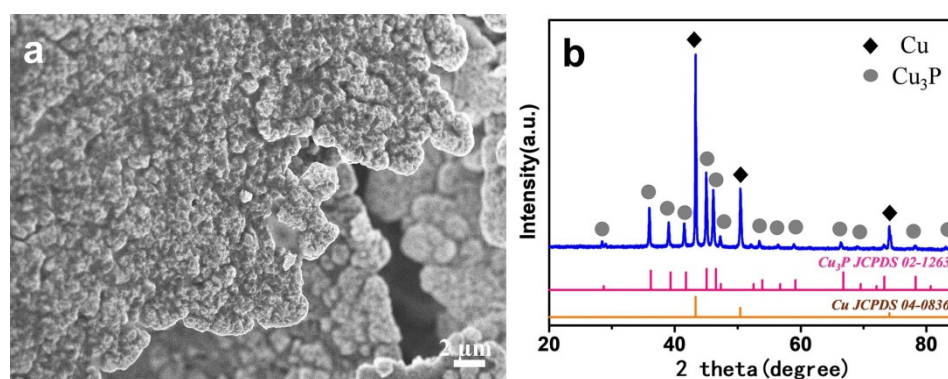


Figure S6. The pure Cu nanosheet was directly phosphating calcined: (a) SEM image; (b) XRD pattern.

Table S1. Comparison of HER catalytic performance of Cu/Cu₃P nanoarrays-270 and other non-noble metal electrocatalysts in acidic media.

Materials	Overpotential (η_{onset} , mV)	Overpotential (η_{10} , mV)	Ref
Cu ₃ P nanocubes	145	300	53
Cu ₃ P nanowires arrays	79	143	54
Ni ₁₂ P ₅ nanoparticles	380	-	55
FeP nanosheets	100	250	56
Cu/Cu ₃ P nanoarrays-270	96	253	This work