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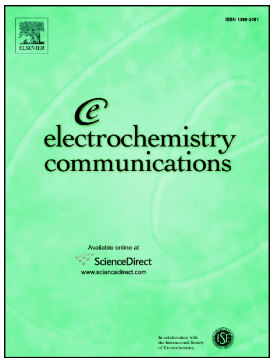

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Simple Synthesis of Two-Dimensional MoP_2 Nanosheets for Efficient Electrocatalytic Hydrogen Evolution

Yunnan Gao[a],† Mingli Zhang[a],† Jingjing Ding[a],† Song Hong[a], Justus Masa[b,c]*, Shizhen Liu[a] and Zhenyu Sun[a,]*

[a] *State Key Laboratory of Organic-Inorganic Composites, Beijing University of Chemical Technology, Beijing 100029, P.R. China*

[b] *Analytische Chemie-Elektroanalytik & Sensorik, Ruhr-University Bochum, D-44780 Bochum, Germany*

[c] *Department of Chemistry, Kyambogo University. P. O. Box 1, Kyambogo, Uganda*

† These authors contribute equally to this work

*Corresponding author. E-mail address: sunzy@mail.buct.edu.cn, justus.masa@rub.de

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Abstract

We report a new method for facile synthesis of MoP_2 nanosheets for efficient electrocatalysis of the hydrogen evolution reaction (HER). The resulting MoP_2 nanosheets catalyze the HER in 0.5 M H_2SO_4 with an overpotential of 150 mV being required to deliver a current of 10 mA cm^{-2}, and a Tafel slope of 81.5 mV dec^{-1} indicating prevalence of a Volmer-Heyrovsky mechanism and hence H_2 desorption as the rate limiting step of the reaction. The HER overpotential remained nearly constant after over 1000 cycles of continuous cyclic potential polarization between 0.0 V and -0.4 V, and 10 h of chronoamperometric polarization at an overpotential of 150 mV. This work expands the synthetic methods for MoP_2 nanosheets as active, acid-stable and non-noble-metal HER catalysts for large-scale hydrogen production.

1. Introduction

Electrolychemical reduction of water offers an environmentally friendly method to produce hydrogen as a future sustainable energy fuel [1]. Traditionally, noble metals such as Pt and Pt-based materials with nearly zero overpotential for the hydrogen evolution reaction (HER) in acidic electrolytes are the best HER catalysts. However, the high cost and scarcity of Pt materials hampers any prospect of upscaling for widespread applications. It is therefore imperative to develop earth-abundant non-noble metal HER electrocatalysts with high current densities at low overpotentials and that simultaneously exhibit long-term stability.

Since molybdenum sulfide was first reported as an excellent alternative to Pt for catalyzing the HER in acidic aqueous solutions, molybdenum-based materials have received considerable attention in the recent past [2,3], and decent activity and stability has been demonstrated in both acidic and alkaline electrolytes [4,5]. In particular, transition metal phosphides (TMPs) such as molybdenum phosphides are among the most promising emergent classes of low-cost HER electrocatalysts [6-8]. Despite these recent advances, HER electrocatalysis using two-dimensional (2D) MoP_2 nanosheets has seldom been reported. A 2D structure is expected to expose a high