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Short Communication

Crossed $FeCo_2S_4$ nanosheet arrays grown on 3D nickel foam as high-efficient electrocatalyst for overall water splitting

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ABSTRACT

Great efforts in developing low-cost, highly efficient and stable electrocatalysts are to tune the chemical compositions and morphological characteristics for enhancing efficiency of water splitting. In this communication, $FeCo_2S_4$ nanosheet was grown *in situ* on nickel foam ($FeCo_2S_4$/NF) via a facile hydrothermal sulfidization method and served as a high-efficient bifunctional electrocatalyst for overall water splitting. As-synthesized $FeCo_2S_4$/NF self-supported electrode delivers 20 mA cm^{-2} at an overpotential of 259 mV toward OER and 10 mA cm^{-2} at an overpotential of 131 mV toward HER in alkaline media. Moreover, when used as both anode and cathode in a two-electrode electrolyzer, only a small cell voltage of 1.541 V is needed to afford a current density of 10 mA cm^{-2} for overall water splitting. Bifunctional electrode $FeCo_2S_4$/NF also revealed a distinguished electrochemical durability during a 12 h stability test at 1.63 V, which would provide a promising water splitting installation for commercial hydrogen production.

Introduction

With drastic depletion of fossil fuels and growing concerns about global environment pollution, numerous efforts have been made to search for renewable and eco-friendly energy as alternatives to traditional fossil energy [1,2]. Owing to its wide range of sources, high calorific value, convenient energy storage and environment friendliness, hydrogen has been considered as an ideal candidate [3]. Water electrolysis, which cannot only meet the potential energy demand but also reduce greenhouse gas emission, has been proved to be a simple and effective method to produce pure hydrogen on large scale [4]. Because the core technology of water splitting cells is energy conversion efficiency, tremendous attempts have been made to reduce energy consumption based on both oxygen evolution reaction (OER) at anode and hydrogen

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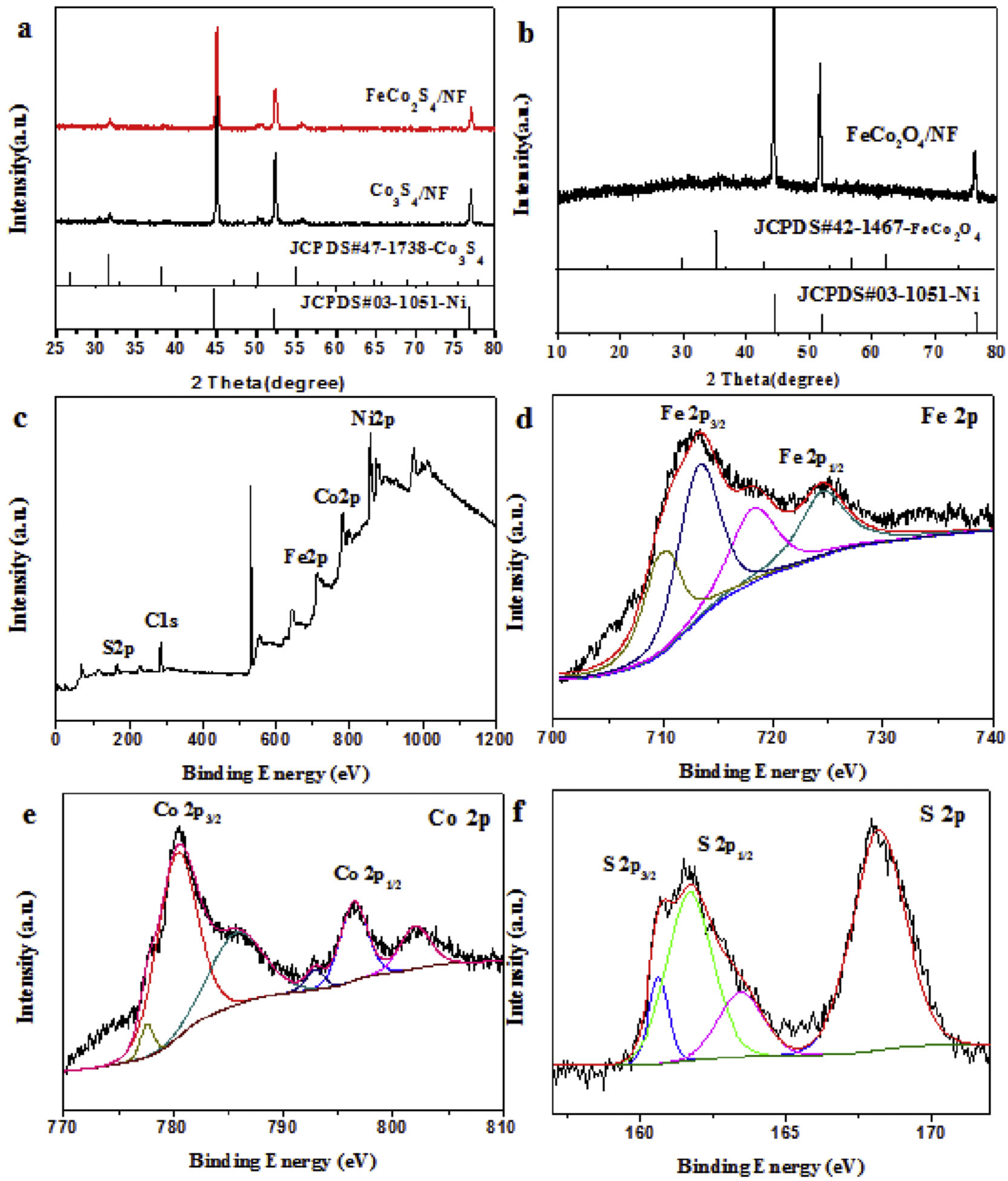

Fig. 1 – XRD patterns of (a) $FeCo_2S_4$/NF,Co_3S_4/NF (b) $FeCo_2O_4$/NF. (c) Survey, (d) Fe 2p, (e) Co 2p and(e) S 2pin $FeCo_2S_4$/NF.

evolution reaction (HER) at cathode [5]. Currently, numerous noble metal materials, such as Ru/IrO_2 and Pt, are known as the most efficient electrocatalysts toward OER and HER, respectively, but low storage and high cost have severely confined their large-scale applications [6,7]. In this regard, substantial research efforts have been devoted to explore high-efficient earth-abundant OER and HER electrocatalysts as alternatives to above-mentioned noble metal materials for actual application [8,9].

Over the past several decades, abundant transition metal based catalytic materials, i.e. oxides, sulfides, hydroxides, phosphates, carbides, selenides, nitrides and phosphides have been confirmed as prospective electrocatalysts because of their high efficiency for OER or HER catalyze [10,11]. However, most of these catalytic materials just possess efficient performance for OER or HER singly, which were unsatisfactory in view of practical application. An efficient water splitting electrocatalyst must exhibit highly catalytic activity for both OER and HER in the same electrolyte, and bifunctional electrocatalyst has attracted extensive attention recently [12,13]. Transition metal sulfides (TMSs), especially for Co_3S_4, have been widely investigated because of its lower intrinsic electrical resistivity and varied electronic feature associated with charge transfer during overall water splitting [14]. Despite tremendous advances have been achieved in this respect, it is still in urgent demand and also a great challenge to explore high-efficient and low-cost bifunctional electrocatalysts for the real commercial productions. As highlighted in recent studies, improvement of catalytic activity mainly depends on the chemical composition tuning and morphological structure

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