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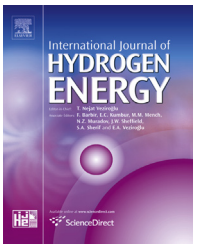

Toward a nanosized iron based water-oxidizing catalyst

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ABSTRACT

Water oxidation is a key step and a bottleneck for large-scale energy storage in artificial photosynthesis. Herein Fe oxide on the surface of fluorine-doped tin oxide electrode was synthesized by a very simple, new and low-cost method, using the reduction of K_2FeO_4 in water. The electrode was characterized by scanning electron microscopy, transmission electron microscopy, energy dispersive spectrometry, X-ray diffraction, diffuse reflectance infrared Fourier transform spectroscopy and Raman spectroscopy. Such fluorine-doped tin oxide electrode could be used as stable water-oxidizing anodes at pH = 13 to yield current densities of 1 $mAcm^{-2}$ at an overpotential of 550 mV.

Introduction

In near future, finding a suitable way to store energy from abundant and sustainable energies is central [1]. Hydrogen is a reliable, independent, sustainable and efficient substitute for the current energy system based on fossil fuels and can be used in direct combustion processes or, even better, in fuel cells [1]. Water electrolysis is a promising approach to the production of hydrogen [2–4]. However, the development of an efficient water-oxidizing catalyst is a key task to yield a significant breakthrough in the water-splitting technology [5–7]. Although expensive metal and metal compounds are long known to be the efficient catalyst for water electrolysis, there are not easy to be used in large-scale due to their high costs [5–7]. Mn [7–12], Fe [13–17], Co [18–20] and Cu [21–25] compounds are synthesized as water-oxidizing catalysts because of the high availability and low toxicity of these metals. Fe is the most abundant transition metal in the earth's crust, and it is less toxic than Co and Ni. However, iron-based films have been less explored as electrocatalysts for water oxidation than those of Mn, Co and Ni oxides because the direct preparation of iron-based films by electrodeposition is not easy and Fe(III) ions will easily precipitate under neutral conditions [26]. Lyons and Doyle reported water oxidation by

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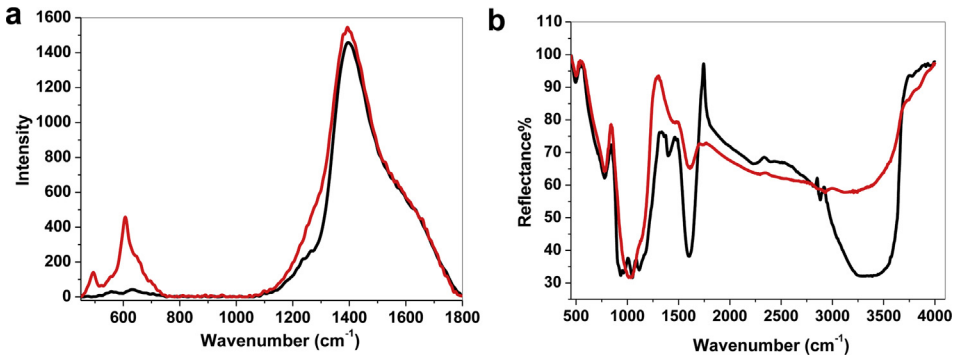

Fig. 1 – The Raman (a) and DRIFTS (b) spectra of FTO (black) and A500 (red). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Fe oxides [26]. The group showed that the rate determining step of the water oxidation reaction depended strongly on conditions, under which the iron oxyhydroxide film was generated.

The oxygen evolution reaction at multi-cycled iron oxyhydroxide films in an alkaline aqueous solution was studied by Doyle and Lyons [27]. Tafel slopes of ca. 60 mVdec^{-1} and 40 mV dec^{-1} were found at low overpotentials depending on

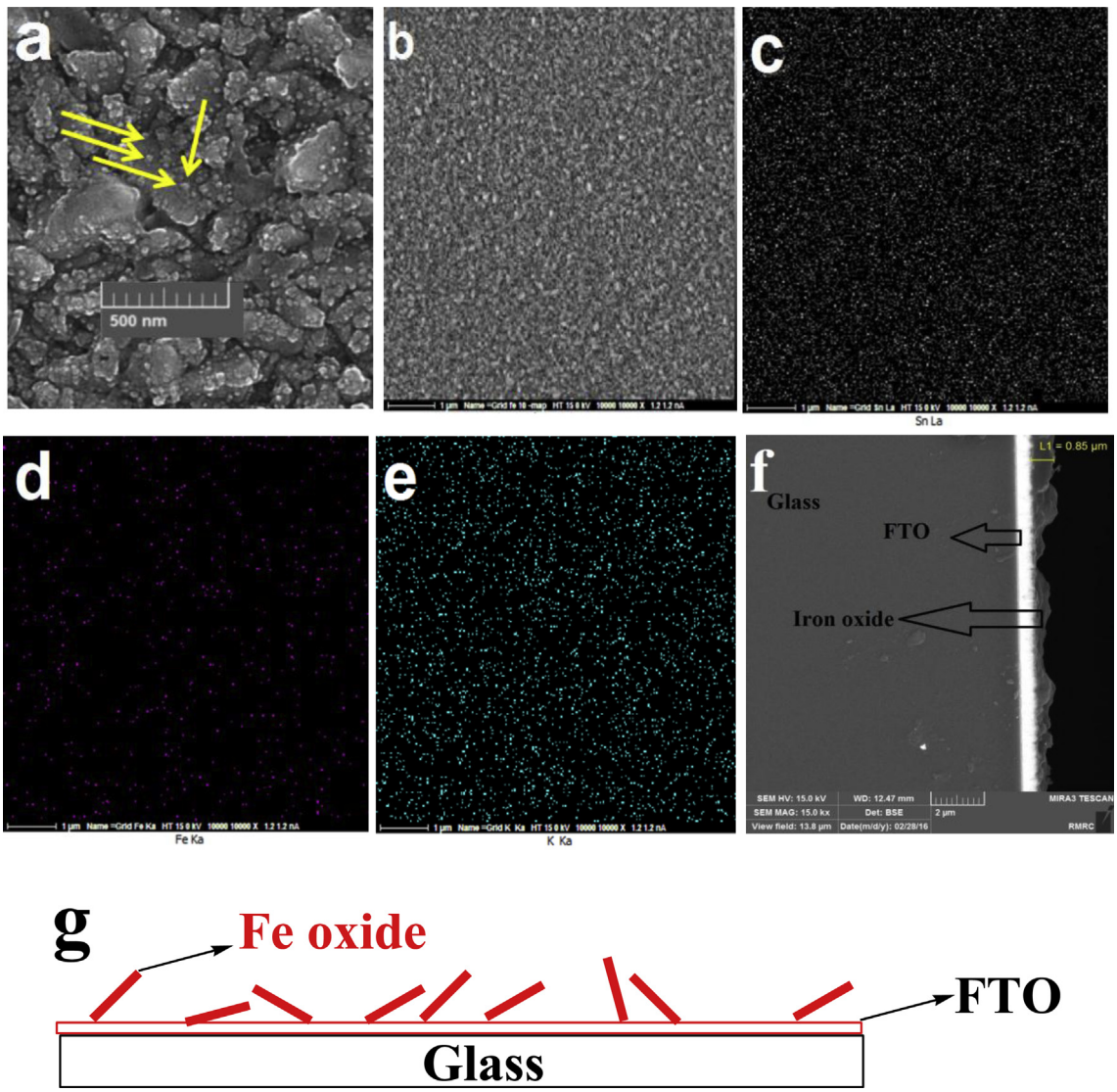

Fig. 2 – SEM images from A10 with scale bar 500 nm (a). EDX–SEM for A500 (b) for Sn(c), Fe(d), and K (e). Cross-sections SEM image of A100 with scale bar 2 μm (f). A schematic image of prepared electrode (g).

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