Accepted Manuscript

Surfactant assisted self assembly of novel ultrathin $Cu[Fe(CN)_5NO]$ nanosheets for enhanced electrocatalytic oxygen evolution: Effect of nanosheet thickness

Sibsankar Rahut, Sovan Kumar Patra, Jayanta kumar Basu

PII: S0013-4686(18)30199-3

DOI: 10.1016/j.electacta.2018.01.152

Reference: EA 31134

To appear in: *Electrochimica Acta*

Received Date: 6 December 2017

Revised Date: 23 January 2018

Accepted Date: 24 January 2018

Please cite this article as: S. Rahut, S.K. Patra, J.k. Basu, Surfactant assisted self assembly of novel ultrathin $Cu[Fe(CN)_5NO]$ nanosheets for enhanced electrocatalytic oxygen evolution: Effect of nanosheet thickness, *Electrochimica Acta* (2018), doi: 10.1016/j.electacta.2018.01.152.

Surfactant Assisted Self Assembly of novel Ultrathin $Cu[Fe(CN)_5 NO]$ Nanosheets for enhanced Electrocatalytic oxygen evolution: Effect of Nanosheet Thickness

Sibsankar Rahut[a], Sovan Kumar Patra[a], Jayanta kumar Basu[a]

[a]*Department of Chemical Engineering, Indian Institute of Technology Kharagpur, Pin- 721302, India*

[*]Corresponding author

Email address: jkb@che.iitkgp.ernet.in; Tel:+913222283914 (Jayanta kumar Basu[a])

Abstract

A morphology-controlled ion exchange route has been investigated for the preparation of Copper Nitroprusside (CNP) nanosheet. Polyvinylpyrrolidone (PVP) was used as capping agent. The effect of PVP concentration during synthesis was also studied which provides a local control over the morphology of CNP nanosheet to produce an ultrathin CNP nanosheet. Effect of PVP concentration in crystal growth and mechanism has been established. Cyclic voltammogram shows that oxygen evolution reaction (OER) onset potential for CNP nanosheet was found to be 1.45 V with a measured current density of 26 mA/cm^2. Linear sweep Voltammetry test has also been conducted to analyze the electrocatalytic OER performance. Anodic slope of Tafel plot establishes higher OER performance of CNP nanosheet than commercial RuO_2. CNP nanosheets was found to be cheap and efficient eletrocatalyst for water splitting reaction. Voltammetric current density has also been expressed as a function of average thickness of nanosheets.

Keywords: Electro-catalysis, Nanosheet, nitroprusside, DFT

1. Introduction

The population of the world is expected to grow rapidly over the next four decades, and with it, the need for fuel. Thus, this situation reflects an imminent threat to our natural resources with fleeting time. Currently, the prevalent energy crisis and the increasing gap in energy demands and its supply across the world makes it important to make a well-advised usage of all the energy resources to its optimum profiteering in up and downstream sectors. It is also important to search for the alternate non-conventional energy sources simultaneously. This will help in creating a solution towards current and future energy requirements, so that the existing resources can be preserved and additionally help economic growth. Various technologies have already been innovated such as fuel cells, metal-air batteries, alkaline battery etc. for more efficient energy conversion[1, 2, 3, 4, 5]. A frequently encountered technique for energy conversion is the water splitting reaction where cathode reduction produces hydrogen and anode oxidation produces oxygen. Oxygen evolution from water splitting is widely reported using metal and metal oxides (Pt, RuO_2, and IrO_2 etc.) over the last several decades[6, 7, 8]. However, for the process of oxygen evolution, to find an inexpensive and competent catalyst remains a challenging task. In a generalized water splitting reaction, the cathodic part serves reduction of water to hydrogen, referred to as Hydrogen Evolution Reaction (HER) whereas, the anodic part serves oxidation of water to molecular oxygen, referred to as Oxygen Evolution Reaction (OER). Oxygen evolution from water requires a higher potential than hydrogen evolution since, OER is a four electron-hole coupled reaction while HER is only a two electron-transfer reaction, so as to overcome the threshold barrier of OER. RuO_2 is a well known novel electrocatalyst in OER applications but it gets oxidized to form RuO_4 under high anodic potential when dissolved in electrolyte solution, thus making it unstable[9, 10, 11, 12]. Similarly, the well-known electrocatalyst IrO_2 in OER application suffers from lower catalytic activity when it gets oxidized to IrO_3 [13]. However, extreme high price and poor availability of these noble metals (Ru, Ir etc.) restrict their large scale applications. Consequently, there is an immediate need to develop efficient electro-catalysts with higher activity and long-term stability. Intensive research with notable advances have