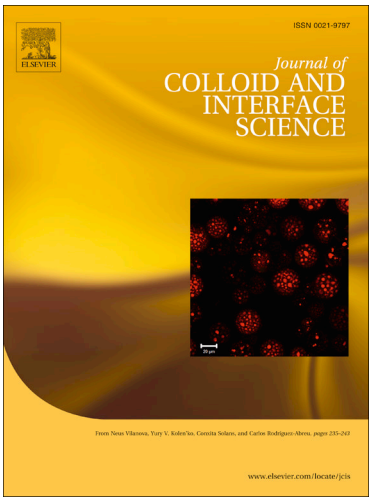

Rapid synthesis of platinum-ruthenium bimetallic nanoparticles dispersed on carbon support as improved electrocatalysts for ethanol oxidation

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Rapid synthesis of platinum-ruthenium bimetallic nanoparticles dispersed on carbon support as improved electrocatalysts for ethanol oxidation

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Abstract:

Bimetallic nanocatalysts with small particle size benefit from markedly enhanced electrocatalytic activity and stability during small molecule oxidation. Herein, we report a facile method to synthesize binary Pt-Ru nanoparticles dispersed on a carbon support at an optimum temperature. Because of its monodispersed nanostructure, synergistic effects were observed between Pt and Ru and the PtRu/C electrocatalysts showed remarkably enhanced electrocatalytic activity towards ethanol oxidation. The peak current density of the Pt_1Ru_1/C electrocatalyst is 3731 mA mg^{-1}, which is 9.3 times higher than that of commercial Pt/C (401 mA mg^{-1}). Furthermore, the synthesized Pt_1Ru_1/C catalyst exhibited higher stability during ethanol oxidation in an alkaline medium and maintained a significantly higher current density after successive cyclic voltammograms (CVs) of 500 cycles than commercial Pt/C. Our work highlights the significance of the reaction temperature during electrocatalyst synthesis, leading to enhanced catalytic performance towards ethanol oxidation. The Pt_1Ru_1/C electrocatalyst has great potential for application in direct ethanol fuel cells.

Keywords: Reaction temperature; PtRu/C nanoparticles; ethanol oxidation; fuel cells

1. Introduction

Ethanol is a valuable product for bioenergy conversion technology. It has been used to develop efficient electrochemical conversion technologies and to produce high value-added energy [1, 2]. Direct ethanol fuel cells (DEFCs) are potential energy devices with high electric efficiency, low operating temperature, and low pollution and they are relatively inexpensive and easy to purify [3, 4]. It has been reported that ethanol can be used as a fuel for direct fuel cells (DFCs) under alkaline conditions where platinum is commonly employed as anode catalyst [5].

Considering that pure Pt anodes are commonly poisoned by surface-absorbed reaction intermediates that are generated during ethanol oxidation, many strategies to enhance their electrocatalytic performance have been developed. One method is to synthesize Pt-based bimetallic catalysts by combining Pt with Pd [6], Ni [7] or Au [8], which can effectively increase the electrocatalytic activity due to their bifunctional mechanism or because of synergistic or electronic effects. Several studies have reported that Ru, an oxophilic metal, may help the dissociative adsorption of H_2O to