

Effect of the structure of Ni nanoparticles on the electrocatalytic activity of Ni@Pd/C for formic acid oxidation

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Abstract

Ni@Pd/C catalysts were synthesized, using Ni/C with different crystalline structures prepared with various ligands. A series of characterizations were performed by transmission electron microscopy, X-ray diffraction, X-ray photoelectron spectroscopy. The results indicated the electrocatalysts with amorphous/crystalline (denoted as Ni_a and Ni_c) Ni structures decorated with Pd. The formic acid electrocatalytic oxidation results showed that the peak current of Ni_a@Pd/C was about 1.2 times higher than that of Ni_c@Pd/C. The good electrochemical performance and stability of Pd-modified amorphous Ni substrate reveals that the core structure plays an important role in the electrocatalytic activity and the change of the structure can improve the activity and stability of electrocatalysts.

1. Introduction

If the goals of attaining practical power levels and reducing manufacturing costs are reached, direct formic acid fuel cells (DFAFC) may become promising alternative portable power sources [1e3]. Among problems that still need to be overcome are insufficient electro-catalytic activity of the anode catalyst for formic acid oxidation and catalyst deactivation due to formic acid oxidation on noble-metal catalysts that generates intermediates such as CO that can be adsorbed on the noble-metal catalysts' surface [4]. Although Pd/C electrocatalyst exhibited much better activity than Pt/C, its activity was still not satisfactory, and more importantly its durability was in urgent need for further improvement because of rapid deactivation of this catalyst [4e6]. Hence, it is important to develop new catalysts with high activity and stability for formic acid oxidation.

To increase the catalysis activity and reduce noble-metal loading, bimetallic catalysts of palladium alloyed with a non-noble-metal are often used [5,7e9]. Among different bimetallic catalysts, PdNi alloy catalyst has attracted most attention owing to its strong formic acid oxidation enhancement [10e12]. PdNi bimetallic alloy not only increases the active surface area of the Pd-based catalysts, offering more active sites necessary for the formic acid dissociation, but also results in the modification of electronic structure of palladium by Ni atoms which facilitate the removal of

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