Carbon Supported Pd-Ni-P Nanoalloy as an Efficient Catalyst for Ethanol Electro-oxidation in Alkaline Media

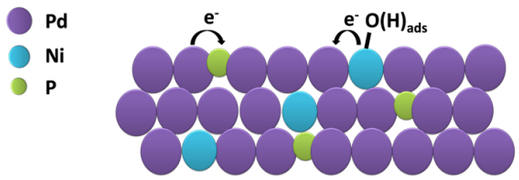
Ye Wang, Yao-Yue Yang, Wen-Bin Cai*

Shanghai Key Laboratory of Molecular Catalysis and Innovative Materials, Collaborative Innovation Center of Chemistry for Energy Materials, Department of Chemistry, Fudan University,
*E-mail: wbcai@fudan.edu.cn

The wide use of rare and expensive Pt in the catalysts is a bottleneck for developing direct ethanol fuel cells (DEFCs). Fortunately, Pd-based catalysts show a rather high electrocatalytic activity for ethanol oxidation in alkaline media, thus could be developed as an anode catalyst for the alkaline anion exchange polymer electrolye fuel cells [1]. Based on the mechanistic understanding of ethanol oxidation reaction (EOR), one way for developing new efficient anode nanocatalysts is to take advantages of tunable electronic, geometric and/or bifunctional effects brought by alloying the primary catalytic element Pd with more than one element [2].

Here, we synthesize for the first time a well-dispersed Pd-Ni-P/C ternary nanocatalyst targeted for EOR in alkaline media with a mean size of ca. 4.3-nm. Cyclic voltammograms indicate that the Pd-Ni-P/C catalyst presents a remarkably higher activity for EOR than state-of-the-art Pd/C, Pd-P/C and Pd-Ni/C nanocatalysts. XRD analysis reveals that Ni shrinks while P expands the Pd lattice structure, the apparently opposite effects of the alloying elements P and Ni on Pd lattice constant enable conveniently to tune geometric and electronic properties of Pd in the ternary catalyst [3]. XPS measurement suggests different electronic effects of the two alloying elements on Pd. The mixed pattern of Ni, P and Pd sites at nanoalloy surfaces lowers the ratio of CO_B to CO_L on Pd sites due to the so-called geometric effect [4]. Based on the above compositional and structural analyses, the outstanding performance of Pd-Ni-P/C may be ascribed to the suitably weakened adsorption of surface species on Pd sites and the readily available reactant pair (O-containing species) on neighboring Ni sites, thereby to enhance the EOR at least through the promotion of the CO_{ads} intermediate reaction pathway.

This present work may trigger new exploration of multi-component Pd-based nanocatalysts for EOR, thus promote the development of alkaline DEFCs.



Scheme 1. Scheme of atomic arrangement for Pd-Ni-P ternary alloy.

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Reference

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