Carbon Supported Pd-Pt-Cu Nanocatalysts for Efficient Formic Acid Electrooxidation: Facile Syntheses, Componental Functions and Structural Evolutions

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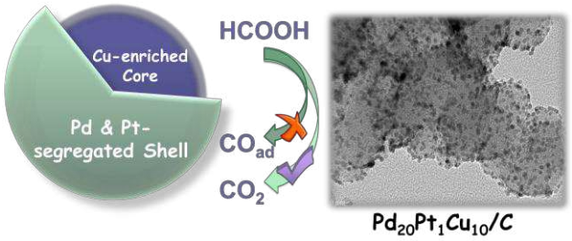
Pd-based nanoalloys supported on carbon black with favorable sizes and structures as well as homogeneous dispersions are receiving a great interest owing to their potential applications in various catalytic reactions including anode reactions in low-temperature fuel cells [1]. In order to get a significant and balanced improvement on the catalytic activity and durability of a Pd-based nanocatalyst for a specific reaction, rational design and synthesis, structural analysis, performance evaluation and insightful understanding of multi-component nanoalloys are essential, and yet remain as a challenge.

In the present work, we have comparatively screened several one-pot synthetic methods for preparing highly dispersed carbon-supported low Pt-contented Pd-Pt-Cu nanocatalysts with readily cleanable surfaces and different alloying degrees by varying reducing agents, solvents and stabilizers. $Pd_{20}Pt_1Cu_{10}/C$ synthesized with ethylene glycol and sodium citrate has been identified to exhibit the best electrocatalysis towards formic acid oxidation (FAO) among all the tested samples including mono-, bi-, and tri-metallic Pd nanocatalysts. Moreover, a comprehensive investigation with combined XPS, electrochemical and ATR-IR measurements enables a better understanding of the compositional and structural origins [2] leading to such an enhanced electrocatalysis. It is revealed that the cheaper Cu functions mainly as the "core filler" to expose a Pd and Pt-segregated active surface and a deliberately controlled small fraction of Pt on the surface minimizes the undesired dehydration of formic acid [3], in addition, a weak electronic effect from Cu and Pt promotes FAO on Pd. Surface restructuring with Pt agglomeration due to intense Cu dealloying procedure [4] degrades the performance of the ternary nanocatalysts. The current work may lend new hints for the development of high performance multi-component electrocatalysts towards better clean energy utilization.



Scheme 1. Schematic structure and TEM images of the trimetallic Pd-Pt-Cu/C nanocatalysts.

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