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Micro/nano-architecture assisted electrochemistry on electrode materials bioinspired by butterfly wings

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Rapid depletion of fossil fuels raises serious energy and environmental problems. Electrochemistry which converts chemical energy into electrical energy/signal with little or no pollution is a more sustainable and environmentally friendly way to support the fast developing world. Researching and developing efficient electrode materials is a basic and essential issue to promote electrochemical performance in almost all electrochemical devices. Due to its high specific surface area, micro/nano architectured electrodes are increasingly investigated and studied. In the past few years, our group use butterfly wings as template warehouse to obtain electrode materials with various elaborate micro/nano-architectures and explore architecture effects on different electrochemical systems. Pt samples with three different butterfly-wing architectures were synthesized through electroless deposition and investigated as anode materials for methanol oxidation. Lamellar ridge-Pt was proved to exhibit the best electrocatalytic performance, whose methanol oxidizing peak current density was 5.2 times higher than its unarchitectured counterpart. This work confirms the lamellar ridge butterfly-wing architecture as one of the most effective electrode architectures, which shows great application potential in the electrochemical arena. To extend application arena to electrochemical detection, lamellar ridge-Au was fabricated using the same method. The sensitivity for glucose electrochemical detection was increased by 5.8 times and the detection limit was lowered by 3.7 times compared to its unarchitectured counterpart. According to simulation results, an efficient zigzag diffusion in the lamellar-ridge architecture and more efficient "thin layer diffusion" in the space of adjacent lamellae occurred for rapid transport and depletion of electrolytes. By combining experimental and simulation method, these efforts provide a simple and reliable way to select efficient micro/nano-architectures for electrode based on the structural pool of butterfly-wings. These efforts may provide reference and prototype for future structural design of electrode materials with enhanced electrochemical performance.

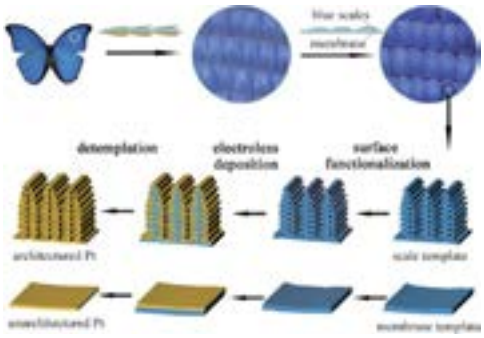

Figure 1: Schematic diagram of the preparation process of architectured Pt and unarchitectured Pt using lamellar-ridge architectured blue scales and flat membrane from Morph butterfly wings as sample templates through surface functionalizing, electroless deposition, and detemplating procedure.

Biography

Tongxiang Fan received his PhD in Materials Science from Shanghai Jiaotong University in 1999. He is currently a Professor of Materials Science in Shanghai Jiaotong University, China. He has received several scientific awards, including the STA Fellowship (Japan, 2000) and Fok Ying Tung Foundation (Hong Kong, 2003). His main research interests focus on bioinspired/biomimetic materials and their applications in energy and environmental fields.

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