Department of
Biomedical Engineering
香港城市大學
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BME-CHEM Joint Seminar

Intermetallic nanoparticles: their synthesis and enhanced electrocatalysis

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Yeung Kin Man Academic Building

Abstract

Intermetallic nanoparticles (NPs) are a class of transition metal-based alloy NPs within which metal atoms are bonded via strong d-orbital interaction in a specific crystallographic direction. Compared to the common metallic alloy NPs with solid solution structure, intermetallic NPs are generally more stable against chemical oxidation and etching, making them an ideal choice as catalysts in corrosive reaction systems.

This talk focuses on monodisperse intermetallic L10-structured MPt NPs, especially Pt-, Pd-, and Au-based L10- NPs, as robust catalysts for electrochemical reduction and oxidation reactions.

Intermetallic core/shell L10-FePt/Pt NPs with ~2 atomic layers of Pt shell were made by controlled annealing and acid etching of solid solution FePt NPs. The core/shell structure with compressed Pt shell is chemically stable against fast/deep Fe etching and is catalytically more active than the Pt counterpart for oxygen reduction reaction (ORR), showing superior mass activity and much better durability under the fuel cell testing conditions at 80°C. When Fe is replaced by Co in the L10-FePt/Pt structure, the Pt shell in the L10-CoPt/Pt structure is compressed even more, and its ORR catalysis is further enhanced. At 60°C in 0.1 M $HClO_4$, the L10-CoPt better stabilized Co (5% loss after 24 h) than the solid solution structured A1-CoPt (34% loss in 7 h). The L10-CoPt/Pt showed ORR mass activities (MA) of 0.56 A/mgPt initially and 0.45 A/mgPt after 30,000 voltage cycles in the membrane electrode assembly at 80°C. When alloyed with Au, the AuPt shell in the L10-MPt/AuPt structure (M = Fe or Co) is more active and stable for electro-oxidation of formic acid and alcohols. Our studies demonstrate a reliable way of tuning NP catalysis from electrochemical reduction to oxidation reactions via a simple control of surface alloying effect. This core/shell catalysis tuning strategy can be further extended to many other composite structure systems, such as MAu/Au and MPd/Pd systems, opening a new path to tune and optimize NP catalysis for redox reactions that are key to green chemistry and sustainable energy.

Biography

Shouheng Sun received his BSc from Sichuan University (China), MSc from Nanjing University (China), and PhD from Brown University (USA). He joined the IBM T. J. Watson Research Center (Yorktown Heights, New York, USA) first as a postdoctoral fellow (1996-1998) and then as a research staff member (1998-2004). In 2005, he returned to Brown University as a tenured Associate Professor and was promoted to full Professor in 2007. He has been the Vernon K. Krieble Professor of Chemistry and Professor of Engineering since 2016. His main research interests are in chemical synthesis and self-assembly of nanoparticles for catalytic, magnetic and biomedical applications. He served as a co-Director of Brown's Institute of Molecular and Nanoscale Innovation (2008-2020).

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