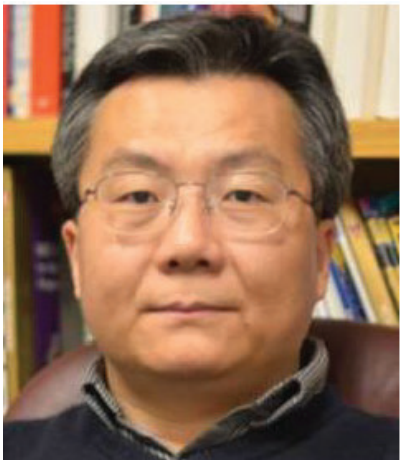
A NanoBioLab Symposium 2021 Webinar

Prof. Shouheng Sun, Brown University

INTERMETALLIC NANOPARTICLES: THEIR SYNTHESIS AND ENHANCED ELECTROCATALYSIS



Thursday, March 18, 2021
9:00 - 10:00 am SGT
Click Here to Join Us on Zoom
Meeting ID: 929 6848 2243
Passcode: 423412

Prof. Shouheng Sun

Vernon K. Krieble Professor of Chemistry and Professor of Engineering, co-Director of the Institute of Molecular and Nanoscale Innovation, Brown University

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 $L1_0$-structured MPt NPs, especially Pt-, Pd-, and Au-based $L1_0$-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 $L1_0$-FePt/Pt structure, the Pt shell in the $L1_0$-CoPt/Pt structure is compressed even more and its ORR catalysis is further enhanced. At 60°C in 0.1 M $HClO_4$, the $L1_0$-CoPt better stabilized Co (5% loss after 24 h) than the solid solution structured A1-CoPt (34% loss in 7 h). The $L1_0$-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 $L1_0$-MPt/AuPt structure (M = Fe or Co) is more active and stable for electro-oxidation of formic acid (11.97 A/mgPt), methanol (1.49 A/mgPt) or even ethanol (1.55 A/mgPt) in 0.1 M $HClO_4$. Our studies demonstrate a reliable way of tuning NP catalysis from electrochemical reduction to oxidation reactions via a simple control of surface alloying effect, which will be important for developing high performance NP catalysts for energy conversion reactions.

ABOUT THE SPEAKER

Shouheng Sun received his BSc from Sichuan University (China) in 1984, MSc from Nanjing University (China) in 1987, and PhD from Brown University in 1996. He joined the IBM T. J. Watson Research Center first as a post-doctoral fellow (1996-1998) and then as a research staff member (1998-2004). In 2005, he returned to Brown as a tenured Associate Professor and was promoted to full Professor in 2007. He is now the Vernon K. Krieble Professor of Chemistry and Professor of Engineering, co-Director of the Institute of Molecular and Nanoscale Innovation of Brown University, Associated Editors of the Royal Society of Chemistry journals Nanoscale/ Nanoscale Advances, and the Fellow of the Royal Society of Chemistry. His main research interests are in chemical synthesis and self-assembly of nanoparticles for catalytic, magnetic and biomedical applications.

Organized by

Agency for Science, Technology and Research
SINGAPORE
NanoBio Lab

Symposium Organizer: Prof. Jackie Y. Ying, A*STAR Senior Fellow, NanoBio Lab

For enquiries, please contact nidyah@nbl.a-star.edu.sg