MSE-Colloquium@NTU

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Designing Advanced Materials for Energy Storage and Conversion

Dr Seh Zhi Wei

Scientist III, NRF Fellow

Institute of Materials Research

Abstract

Achieving a sustainable energy future is one of the key challenges facing humanity today. When coupled with renewable energy, advanced batteries have the ability to power light duty transport, such as electric cars and buses, while electrocatalysis can convert simple molecules into valuable fuels to power heavy duty transport, such as trucks, marine and aviation. In this talk, I will discuss our recent work in designing new materials for advanced battery and electrocatalyst systems.

Lithium-sulfur batteries represent a very attractive energy storage system as their specific energy is much higher than that of lithium-ion batteries which we use today. The first part of my talk will be focused on the design of new encapsulated sulfur cathodes for lithium-sulfur batteries. Using S-TiO_2 yolk-shell nanostructures, we achieve a high specific capacity of 1,030 mAh/g over 1,000 charge/discharge cycles. By synthesising Li_2S-TiS_2 core-shell nanostructures, we further demonstrate a high specific capacity of 722 mAh/g at 4C and areal capacity of 3.0 mAh/cm^2. This work opens up the prospect of using transition metal oxides and sulfides instead of typical carbon for effective encapsulation of high-capacity electrode materials.

Hydrogen evolution via electrocatalysis can enable sustainable production of molecular hydrogen as a clean energy carrier. The second part of my talk will be focused on the application of 2D transition metal carbides (MXenes) as electrocatalysts for hydrogen evolution. We controllably prepared molybdenum carbide Mo_2CT_x MXenes which exhibit a current density of 10 mA/cm^2 at 189 mV overpotential in acid. Importantly, our results indicate that the basal planes of Mo_2CT_x MXenes are catalytically active towards hydrogen evolution, unlike the case of the widely studied 2H-phase MoS_2, in which only the edge sites are primarily active. These results pave the way for rational design of promising 2D materials for electrocatalysis.

Biography

Dr Seh Zhi Wei is a Scientist III and NRF Fellow at the Institute of Materials Research and Engineering, A*STAR. He is also an Adjunct Assistant Professor at Nanyang Technological University, Singapore. Dr Seh received his BS and PhD degrees in Materials Science and Engineering from Cornell University and Stanford University respectively. His research interests lie in the design of new materials for energy storage and conversion, including advanced battery and electrocatalyst systems. He has published in top journals, such as Science, Nature Energy, Nature Communications and Nature Catalysis, achieving a H-index of 31. For his research achievements, he received numerous awards, including Highly Cited Researchers (Clarivate Analytics), Emerging Investigators (Journal of Materials Chemistry A), Singapore NRF Fellowship (National Research Foundation) and Innovators under 35 Asia (MIT Technology Review).

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