Department of Materials Science and Engineering Seminar Series 2025

Engineered 3D Nanoporous Carbon Matrices for Energy and Environmental Applications

Pu Yanhui

Date and time: 10th March 2025 (Monday) 2:00PM – 4:00PM

Venue: EA-06-04

Abstract

Carbon matrices are widely reported to improve the durability and efficiency of active materials in energy and environmental applications. However, the practical application of carbon matrices is limited by common issues, such as inadequate mechanical properties, limited tunability of surface area and pore structure, and weak interactions with active materials. In this thesis, a robust 3D nanoporous carbon with a tunable surface area and pore structure, derived from inexpensive commercial carbon nanoparticles, was explored as a versatile matrix for various applications. First, MoS_2 was conformally deposited onto the 3D nanoporous carbon, and the composite exhibited high stability as an anode for lithium-ion batteries. Next, MoS_2 was embedded in this carbon matrix as a catalyst for the hydrogen evolution reaction, exhibiting improved catalytic activity and good stability. In addition, the MoS_2-decorated 3D nanoporous carbon was studied as a catalyst for the hydrogenation of CO_2 to methanol, and the MoS_2-embedded structure was found to influence the interaction between gas reactants and active sites. Furthermore, the 3D nanoporous carbon was investigated as a sulfur cathode host for lithium–sulfur batteries, showing sulfur anchoring ability, which originates from its unique crumpled surface with a microporous structure. Therefore, this 3D nanoporous carbon matrix is adaptable for multiple applications, demonstrating significant industrial potential.

Biography

Pu Yanhui received his bachelor's and master's degrees in Materials Science and Engineering from Beihang University. He is currently a Ph.D. candidate in the Department of Materials Science and Engineering under the supervision of Prof. Barbaros Özyilmaz. His research focuses on new carbon matrices for battery and catalyst applications.

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