

Abstract of Plenary Talk

The new era of plasma engineering for materials synthesis and surface modification for renewable energies

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Plasma, consisting of electrons, ions, molecules, radicals, photons, and other excited species, has complex atomic and molecular processes and versatile physical and chemical reactions with solid materials. Frontier research based on plasma process and engineering has been expanded to electrochemical energy storage systems and renewable energy conversions. This presentation discusses the contribution of plasma engineering to the synthesis and surface modification of catalytic and electrode materials, emphasizing their application in fuel cells, hydrogen production, and biomass upgrades. Unlike conventional syntheses, plasma engineering allows direct carbonization to synthesize carbon nanomaterials in organic solvent (e.g., benzene, pyridine, phenylamine) at ambient temperature and pressure. Direct carbonization proceeds by combining CN and C₂ radicals with the solution precursor at the gas/liquid interface. One-step hybrid metal/carbon materials synthesis can be realized when metal precursors are introduced into the organic solution. In addition, when applied in-situ ultrasonic homogenizer during plasma engineering, ultra-fine and dispersed metal nanoparticles or even single-atom doped metal in carbon substrate was successfully synthesized. The design, synthesis, and modeling of novel plasma engineering on hybrid metal /carbon-supported materials, halogen-doped sulfonated carbons, nitrogen doped carbon coated metal quantum dots, etc., as well as the current progress on plasma-engineered catalytic performance in various applications including proton electrolyte membrane fuel cell, metal-air seawater batteries, alkaline and seawater electrolysis and biofuel production. Finally, the future research directions, challenges, and opportunities of plasma-based synthesis process as a novel fast-throughput synthesis route will be discussed.