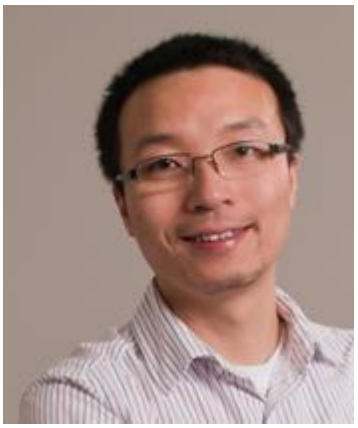

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Highly Efficient and Durable Catalysts or Fuel Cell Applications

Abstract.

Fuel cells are electrochemical devices that oxidize fuel (hydrogen, hydrocarbons, and alcohols) at the anode and reduce oxygen at the cathode to produce electricity. They are one of the most promising sources for clean energy in the near future. However, inadequate efficiency, poor durability, and high cost of the catalysts in fuel cells constitute the major barriers to their full commercialization. The goal of this research is to develop a novel class of fuel cell catalysts with superior activity and durability at low cost. Specifically, three different Pt-based multi-component nanoparticles with high index facets: alloys, monolayer core-shell structures, and heterometallic composites, will be judiciously designed and synthesized. This new type of nanoparticle catalysts is advantageous because they benefit from both improved electron transfer kinetics due to the multiple components and enhanced reactivity resulting from the highly stepped surfaces. The electrocatalytic properties of the catalysts in three typical fuel cell reactions, oxygen reduction, methanol/ethanol oxidation, and formic acid oxidation, will be evaluated and are expected to meet the requirement set by DOE. Moreover, the relationship between the structure and catalytic properties will be investigated to achieve a fundamental understanding of catalytic mechanism at an atomic level, which is useful to direct future designs and syntheses. Further, the proposed research can provide insights for other energy related research such as lithium-air batteries and electrochemical water splitting. It can also enhance the competitiveness of Nebraska in energy research and help to develop a clean and sustainable energy economy for Nebraska in the future. .