THE DEVELOPMENT OF MULTI-FUNCTIONAL CATALYSTS TO REPLACE PT FOR FUEL OXIDATION REACTIONS IN LOW TEMPERATURE FUEL CELLS TOWARD ENVIRONMENTALLY FRIENDLY ENERGY PRODUCTION

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The environmentally friendly generation of energy has brought new scientific and technological challenges. Among the various alternative systems for energy production, fuel cells are particularly attractive because they allow clean and efficient conversion of chemical energy into electricity. Currently, the most active catalyst for the oxidation of fuels such as hydrogen, methanol and ethanol in fuel cells are Pt and Pt-based materials, which are too expensive for affordable clean energy production. The development of catalysts based on cheaper materials for fuel oxidation reactions in fuel cells is needed. The proposal aims to develop novel multi-functional catalysts to replace Pt for fuel oxidation reactions in fuel cells through collaborative efforts by electrochemists from Brazil, USA and China. Specifically, combining electrochemical measurements, in-situ spectroscopy characterizations, density functional theory simulations and fuel cell testing, the joint team will focus on studying reaction mechanisms of hydrogen, methanol and ethanol oxidation reactions (HORs, MORs and EORs) on various catalysts in both acid and alkaline media. Through understanding how surface and electronic structures of various catalysts affect the reaction kinetics of HORs, MORs and EORs in acid verse alkaline media, new multi-functional catalysts based on low cost materials (such as Pd, Ni and other earth abundant elements) with comparable HORs, MORs and EORs activity to Pt-based catalysts will be designed and characterized. For example, alloying Pd with transition metals will induce structural changes that alter the electronic characteristics of Pd surface active sites and the availability of oxygenated species on the catalyst surface needed to oxidize alcohol and its fragments. The effects of electronic properties on reactivity will also be investigated by varying metal-support interactions. The successful execution of the proposed project will provide viable new non-precious metal catalysts for fuel oxidation in fuel cells and a means to produce energy in an environmentally friendly fashion.

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