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A New Class of Electrocatalyst Materials for Direct Methanol Fuel Cell Applications

Syed M. Javaid Zaidi[1], Amir Al-Ahmed[2], Mukhtar Bello[3]

[1]QAFAC Chair, Center for Advanced Materials (CAM), Qatar University, Qatar
[2]Center of Research Excellence in Renewable Energy, King Fahd University of Petroleum & Minerals, Saudi Arabia
[3]Department of Chemical Engineering, Ahmadu Bello University, Zaria, Nigeria

Email: szaidi@qu.edu.qa

Abstract

Direct methanol fuel cell (DMFC) has been attracting lots of attention as a power source for transportation, stationary and portable electronic devices due to the high energy density of methanol and ease of handling compared to gaseous fuels such as hydrogen and natural gas. However, the commercialization of DMFC is still limited due to some technical challenges such as methanol crossover and low methanol electro-oxidation kinetics. In order for fuel cells to be a feasible and viable option amongst clean energy technologies, innovations in the materials developments are required for efficient operation of fuel cells. Many efforts have been made in various research laboratories to develop high-performance catalysts that will enhance the methanol electro-oxidation. Compared to any single-metal catalyst, Pt has shown the highest activity for the electro-oxidation of methanol in an acid environment. However, Pt is expensive and during the methanol electro-oxidation reaction, COads and other organic intermediates such as formaldehyde, formic acid and methyl formate are formed on the Pt surface, which results in poisoning of the Pt catalyst.

Many binary and ternary catalysts for methanol electro-oxidation have been investigated and reported in the literature, most of them based on modification of Pt with some other metal(s). The aim is to accelerate the oxidation of the intermediates and decrease their accumulation so as to improve the catalyst performance. Among the various catalyst formulations, PtRu alloy has shown the best results for the methanol electro-oxidation. Diverse methods have been used to prepare the PtRu-based catalysts for methanol electro-oxidation. Catalyst composition and method of preparation are known to immensely affect the physical property es and electrochemical performance of

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a catalyst. Thus, there is the need to use a carefully selected approach in order to prepare a catalyst with the highest attainable performance. Incorporation of transition metals into the PtRu catalysts to form ternary catalysts in order to improve the performance of the PtRu catalysts is one of the techniques attracting a lot of interest. In this work, a novel approach have been used for synthesizing a new class of electrocatalyst nanomaterials for electro-oxidation of methanol by incorporation nano-oxides of transition metals. The prepared nanomaterial catalysts were characterized using FESEM, BET surface area, EDX, FT-IR and XRD. The catalysts performance was studied using cyclic voltammetry and compared with the commercial Pt-Ru/C.