Niobium doped Titania /CNT hybrid as Pt electrocatalyst support for methanol oxidation

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Abstract

Direct methanol fuel cell (DMFC) has attracted extensive attention because methanol is a liquid and has high specific energy at low operation temperatures. However, Platinum anode catalyst, the most popular electrocatalyst for the electro-oxidation of methanol, is often heavily poisoned by the strong adsorption of CO intermediates, which would result in poor electrocatalytic activity[1]. In general, modification of Pt with transition and main group metals, or using high conductivity oxides or metal nitrides as electrocatalyst support was used to mitigate the poisoning CO intermediates[2]. Many oxides such as WO_3 and CeO_2 have been used as support materials and they showed an excellent electrocatalytic activity for methanol oxidation[3].

However, the poor stability of WO_3 and CeO_2 in acid media should be a drawback in the practical applications. Niobium doped TiO_2 (NTO) has been used as an electrocatalyst supported materials for oxygen reduction reaction and methanol oxidation because of their excellent chemical stability and high electronic conductivity in acid media[4]. Doping Nb^{5+} ions into the titania lattice leads to the donation of electrons into the conduction band and thus increases charge carrier concentration, resulting in enhanced electronic conductivity. However, nonhomogeneous distributed Niobium atoms in titania lattice, often caused by high concentration doping and unsuitable defects formed with titanium vacancies and oxygen interstitials, would decrease the electronic conductivity[5]. Therefore, doping process with suitable reaction conditions is critical to obtaining good electronic conductivity of the catalyst supports.

In our work, high concentration (20%) pentavalent Niobium doped titania oxides were coated on the surface of carbon nanotubes (NTO20/CNT). The details of coating process and post thermal treatment were reported in our previous work[6]. The NTO20/CNT was then treated in a hydrogen atmosphere at 800 ^{0}C. Nano-sized Pt particles were deposited on the oxides using a reflux method[7].

XRD analysis showed that hydrogen-treated NTO20 reflected as titania rutile phase and anatase phase, and no Nb_2O_5 phase was detected. This is indicative of that all the niobium elements were fully doped into titania phase. Electrochemical investigation showed that the onset potential for methanol oxidation and mass activity of Pt supported on hydrogen-treated NTO20/CNT t was higher than that of on the NTO20/CNT. Details results will be presented in this presentation.

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