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Effect of the Different TiO_2 Nanostructures in PtRu/C-TiO_2 Catalysts on the Catalytic Activity for Methanol Oxidation

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ABSTRACT

Direct methanol fuel cells (DMFC) are attractive as power sources due to the high energy density and easy handling of the liquid methanol fuel. However, the further development of DMFCs faces serious problems such as low activity of methanol electrooxidation catalysts and poor durability. Among the various bimetallic combinations that have been studied, PtRu has been accepted as the best electrocatalyst for the methanol oxidation reaction (MOR). To obtain a high surface area, PtRu nanoparticles have been synthesized, supported and mixed with different carbon materials; however, the carbon support degrades over time due to electrochemical corrosion. To improve the stability of the support, the addition of metal oxide supports such as WO_3, SnO_2, TiO_2, CeO_2 and SiO_2 has been reported. The characteristics of TiO_2 materials include excellent corrosion resistance in various electrolyte media, electrochemical stability, cost-effective, non-toxic and easily available. Furthermore, titania can enhance catalytic activity of platinum due to a metal-support interaction, nevertheless, the mechanism has not yet been identified.

In this work TiO_2 is used in different structured forms: as nanoparticles (anatase nanoparticles, anatase/rutile nanoparticles), nanowires and nanotubes in combination with Vulcan carbon to serve as support of PtRu catalysts with the aim of evaluating their performance. Chemical reduction method was used to synthesize the catalysts, being ethanolic $NaBH_4$ the reducing agent. XRD and TEM were used for the characterization of the catalysts morphology, while catalytic activity was studied by chronoamperometry and cyclic voltammetry. Results indicate that different TiO_2 nanostructures show different catalytic activities, in all cases higher than the catalyst without TiO_2. Effects on the crystallinity of the Pt fcc structure are also observed which might modify the electronic properties of the catalysts and help to improve the catalytic activity.

Keywords: Direct methanol fuel cell; metal oxide supports.