Preparation of Titanium mixed oxide supported Pt Ru catalysts for Hydrogen Electrochemical Oxidation Reaction of CO/H2

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Abstract

This study explores the production of PtRu catalysts containing Titanium mixed oxide supports as H2 fuel cell anodes and analyzes Hydrogen electrochemical Oxidation activity and CO tolerance. The conductivity of mixed oxide supports are not as good as carbon supports, but its potential advantage is that it is more stable than Carbon supports. The laboratory previously discussed the Titanium-Ruthenium mixed oxide support, during the process of loading Pt, part of Ru will be reduced and precipitated, and it can further form a Pt-Ru alloy phase with Pt, but that the composition structure of the Pt-Ru alloy phase is hard to control. To discuss the improvement of the preparation of mixed oxide supported Pt-Ru alloy catalyst. First, test the effect of pre-processing conditions on the Ti0.7Ru0.3O2, and further adjust the loading parameters of Pt or PtRu. The second is Titanium-Cobalt (or Titanium-Nickel) perovskite oxides supports (CoTiO3, NiTiO3), which have high dielectric properties, special electronic structure and good activity for the complete oxidation of CO and hydrocarbons, and further optimizely adjust the loading ratio of PtRu content to understand the possible role of each component in the catalyst and its influence on the electrochemical reaction characteristics and resistance to CO poisoning.

The research results show that the pre-treated Ti0.7Ru0.3O2-C650 support has better structural stability, and Ru element is not easy to be reduced during the loading Pt process, and the 20Pt10Ru/Ti0.7Ru0.3O2-C650 catalyst has PtRu alloy particle size of about 2 nanometers. Analysis shows that the CO oxidation onset potential is lower than Commercial catalyst (20Pt10Ru/C-JM). And it has better hydrogen oxidation activity and stability with the rotating disk electrode (RDE) analysis by the hydrogen oxidation reaction (HOR) in pure hydrogen, 250 and 500 ppm CO/H2. With CoTiO3-1000 and NiTiO3-1000 as supports loading ratio of PtRu, 30Pt15Ru/CoTiO3-1000, 40Pt20Ru/CoTiO3-1000 and 30Pt15Ru/NiTiO3-1000 catalys are also the PtRu alloy particle size of about 2 nanometers, which has a lower CO oxidation potential than commercial catalysts (20Pt10Ru/C-JM), and better hydrogen oxidation activity and stability. At last, in the long-term CO tolerance test, 30Pt15Ru/CoTiO3-1000 catalyst has the best CO tolerance performance.

Keywords - Titanium mixed oxide, Perovskite, Ethylene glycol method, hydrogen oxidation reaction, CO tolerance

References

[1] Graves, J.E., et al., *The electrochemistry of Magnéli phase titanium oxide ceramic electrodes Part I. The deposition and properties of metal coatings.* Journal of Applied Electrochemistry, 1991. **21**(10): p. 848-857.

[2] X. Zhang, B. Lu, R. Li , C. Fan , Z. Liang, P. Han, *Structural, electronic and optical properties of ilmenite $ATiO_3$ (A=Fe, Co, Ni)* , Materials Science in Semiconductor Processing, vol.**39** (2015) 6–16.

[3] S.M. Brokovic, M.P. Kaninski, P.Z. Lausevic, et al., *Non-stoichiometric tungsten-carbide-oxide-supported Pt-Ru anode catalysts for PEM fuel cells - From basic eletrochemistry to fuel cell performance.* International Journal of Hydrogen Energy, 2020, **45**(27): p.13929-13938.