A highly CO tolerant Pt/nanoporous WC catalyst as anode material for low temperature Fuel Cell

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Introduction

Numerous researches have been done to develop a suitable anode catalyst for low temperature fuel cells such as direct methanol and proton exchange membrane (PEM) fuel cells [1]. Among all the catalysts studied, Pt-Ru alloy show higher and stable elctrocatalytic activity for electrooxidation of hydrogen and methanol. But these catalysts are expensive and susceptible to CO poisoning and lose their catalytic activity with respect to time. There is an urgent need to replace these noble metals.

Tungsten carbide based materials have received considerable attention in recent years because of their resemblance to platinum in various catalytic reactions [2]. They are highly resistant to CO poisoning and stable in acid solution under DMFC conditions. But tungsten carbide alone shows lower electrocatalytic activity for electrooxidation of methanol and hydrogen [3]. But the activity of tungsten carbide can be improved by adding small amount of platinum to tungsten carbide. Recently we prepared tungsten carbide (W_2C phase) microsphere which showed very high activity for electrooxidation of methanol with minimal loading of platinum and without ruthenium [4]. But these catalysts showed lower activity at lower loading of platinum. Among three major phases (W_2C, WC and WC_{1-x}) for tungsten carbide, WC phase is more stable and active for electrooxidation of methanol [3]. We first time prepared nanoporous tungsten carbide (WC phase) by polymer/surfactant method. This presentation concentrates on preparation and detailed characterization of tungsten carbide-based anode materials and their application as an electrocatalyst for low temperature fuel cells.

Materials and Methods

Nanoporous tungsten carbides (WC phase) were synthesized by using ammonium meta tungstate as tungsten precursor and resorcinol – formaldehyde polymer as carbon source in the presence of CTABr surfactant. These materials are characterized by X-ray diffraction (XRD), X-ray photoelectron spectra (XPS), transmission electron microscopy (TEM), temperature programmed desorption (TPD) and cyclic voltammetry (CV).

Results and Discussion

The XRD pattern of nanoporous and nonoparticle tungsten carbides correspond to WC phase. The pore size distribution of nanoporous tungsten carbide shows pore with diameters *c.a.* 4.3 nm. The platinum supported on these materials with a lower loading (3.5 wt%) shows six times higher electrocatalytic activity than commercial 20%Pt-Ru/Vulcan XC-72R carbon for electrooxidation of methanol. This material also shows an excellent CO resistance under PEM fuel cell conditions.

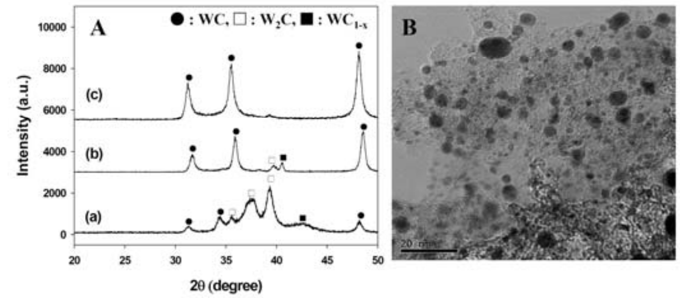

Figure 1. A. X-ray diffraction (XRD) patterns of a) W_2C microsphere, b) nanoporous tungsten carbide and c) tungsten carbide nanoparticle. B. Transmission electron microscope (TEM) image of Pt(3.5wt%) supported on nanoporous tungsten carbide.

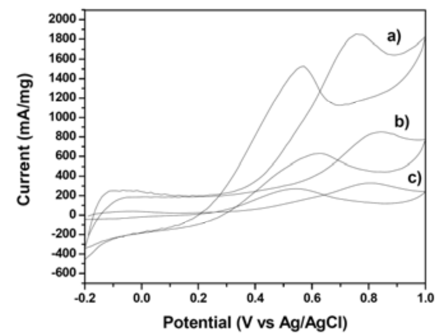

Figure 2. Cyclic voltammogram (CV) of a) 3.5wt%Pt/WC nanoporous, b) 7.5wt%Pt/W_2C and c) 20wt%Pt-Ru/C (commercial E-Tech catalyst) in a 1M H_2SO_4 – 1M CH_3OH solution at a scan rate of 50mV/sec at 298K.

References

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