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Preparation and characterization of Pt/transition metal (Fe, Cu or Sn) phosphate-carbon black catalysts for direct methanol fuel cells (DMFCS)

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Direct methanol fuel cells (DMFCs) are widely used in small-scale portable applications and Pt is the superior and major catalyst in them, due to its excellent catalytic activity and chemical stability. However, Pt catalysts have two major problems should be overcome in DMFCs. One is that CO poisoning effects on the Pt catalysts should be deleted and the other is that the amount of Pt which should be cut for reducing the cost of devices. Although some Pt/transition metal (TM) phosphate catalysts have proved themselves as bifunctional ones, their poor electronic conductivities have resulted in the poor performances in membrane electrode assembly (MEA) tests for DMFCs. In order to enhance their conductivities, the precipitations of Fe, Cu and Sn phosphate (FeP, CuP and SnP), were directly on the surface modified carbon black (CB) to form FeP-CB, CuP-CB and SnP-CB supports, respectively. Then, nano-sized Pt was reduced on them to form Pt/FeP-CB, Pt/CuP-CB and Pt/SnP-CB catalysts and finally annealed at 100 for 3 hours. The features of these catalysts were characterized by the electric resistance measurement, X-ray diffraction, field emission scanning electron microscopy, field emission transmission electron microscopy – live fast Fourier transform, X-ray photoelectron spectroscopy, inductively coupled plasma-mass spectrometry, Fourier transform infrared spectroscopy and cyclic voltammetry. Their electric resistances are reduced to 119, 79 and 85 Ω, resulting in the mass activities enhanced to 132, 328 and 294 (A/gPt), and the on-set potentials lower shifted to 0.250, 0.256 and 0.200 V (vs. Ag/AgCl), in the methanol oxidation reaction (MOR) for Pt/FeP-CB, Pt/CuP-CB and Pt/SnP-CB catalysts, respectively, all revealing no CO poison effects. In MEA tests for DMFCs, they also exhibit the maximum power densities of 27.5, 10.2 and 6.4 mWcm-2mgPt-1and the open circuit voltages (OCV) of 0.480, 0.408 and 0.468 V, much better than the commercial Pt/C. Obviously, the Pt/TM phosphate-CB catalysts have revealed the improved performance due to their well-dispersed catalysts with enhanced conductivity and detoxifying function. However, their onset potentials should be further lowered to perform the comparable OCV to the PtRu/C catalyst.

Biography

Shiow-Kang Yen has completed his PhD. He was the Director of Department of Materials Science and Engineering, National Chung Hsing University. He has published more than 68 papers in reputed journals.

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