Supplementary Material (ESI) for *PCCP*

Supporting Information

Synergy Effect of Nanostructure Electrodes Supported by Tungsten Carbide and Oxide for Methanol Electrooxidation

A-Ra Ko, Jy-Yeon Kim, Jae-Kyung Oh, Hyun-Su Kim, Young-Woo Lee, Sang-Beom Han, and Kyung-Won Park

Department of Chemical and Environmental Engineering, Soongsil University

Seoul 156743, Republic of Korea

*Corresponding author. E-mail: kwpark@ssu.ac.kr

Experimental procedure

Synthesis of Nanostructure electrodes. Nanostructure electrodes were prepared using a radio frequency (RF) magnetron sputtering system. Indium tin oxide coated on transparent glass was used as a substrate. In order to fabricate a thin-film nanostructure, the RF power of the Pt, WC, and WO_3 sputtering guns were individually manipulated. The base pressure was less than 5×10^{-6} Torr and working pressure was 1.1×10^{-2} Torr for all examined. Sputtering was carried out under Ar gas atmosphere at 30 SCCM at room temperature. The Pt-WC and Pt-WO_3 two-phase film was sputter-deposited for 1 min at RF powers of 20 and 100 W on the Pt and WC or WO_3 targets, respectively, and was compared with Pt one-phase film sputter-deposited for 1 min at an RF power of 20 W. The Pt-WC-WO_3 electrode was deposited for 1 min at RF powers of 20, 100, and 100 W on the Pt, WC and WO_3 targets, respectively..

Characterizations. The morphology and size distribution of the catalysts were characterized by field-emission transmission electron microscopy (FE-TEM) using a Tecnai G2 F30 system operating at 300 kV. Cu grids were also used as substrates for analysis by field-emission transmission electron microscopy (FE-TEM). Energy dispersive X-ray (EDX) analysis of the catalysts was performed on a field emission transmission electron microscope (FE-TEM, Tecnai G2 F30 system). X-ray diffraction (XRD) analysis was carried out using a Philips X'pert MPD. The 2θ angular scan from 25 ^{o} to 70 ^{o} was explored at a scan rate of 5 ^{o} min^{-1}.

To evaluate the electrochemical performance of the electrodes, current-potential curves were examined using a conventional three-electrode electrochemical system consisting of a deposited electrode, Pt gauze, and Ag/AgCl as the working, counter, and reference electrode, respectively, at 25 ^{o}C. The solutions of 0.5 M H_2SO_4 and 2.0 M CH_3OH + 0.5 M H_2SO_4 were stirred constantly and purged with argon gas.

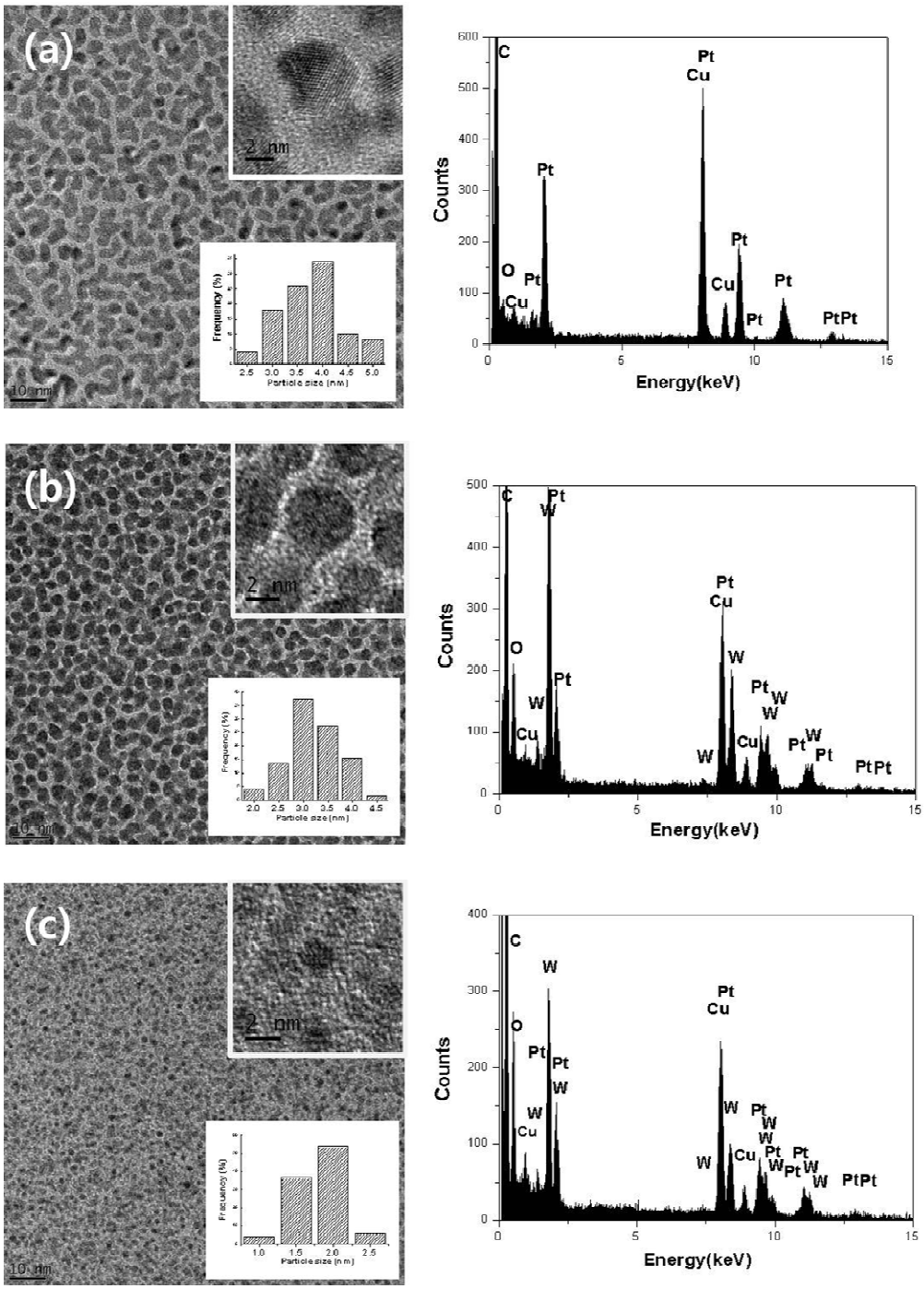

Figure S1. Field-emission TEM image, size-distribution histogram, and EDX spectrum of Pt (a), Pt-WC (b), and Pt-WO_3 (c).

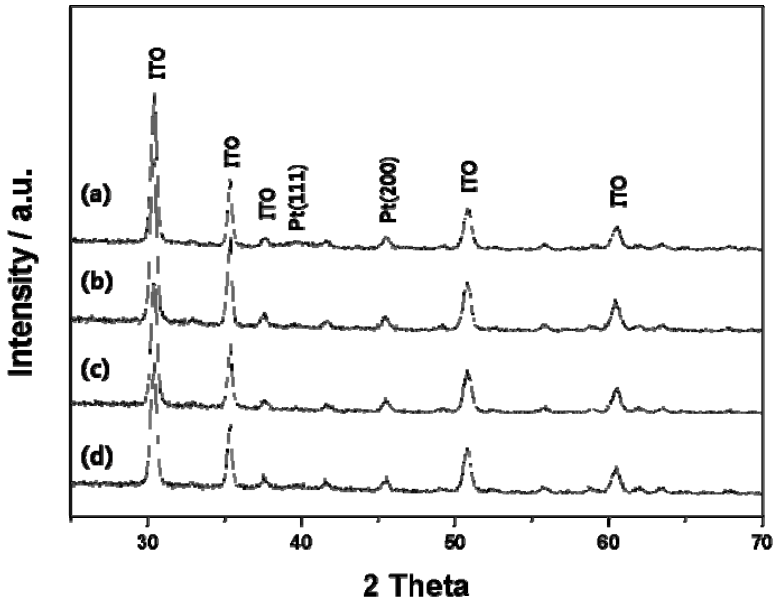

Figure S2. XRD patterns of electrodes ((a) Pt-WC-WO_3, (b) Pt-WC, (c) Pt-WO_3, and (d) Pt) prepared by sputtering method.