Metal Load Effects on the Electrocatalytic Activity of Ag@Pt-Pd Core@Shell Nanoparticles toward the Oxygen Reduction Reaction

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ABSTRACT

Ag@Pt-Pd core-shell electrocatalyst with four different loads were prepared by sonication and deposited on XC-72 Vulcan carbon. The loads of Catalysts were of 5, 10, 20 and 30% weight, respect to Carbon, commercial catalyst with 20% weight of platinum was used to compare. Measurements with dynamic light scattering (DLS) show particle average size for the core-shell nanoparticles of 40nm and 15nm for the Ag. The X-ray Diffraction pattern of Ag@Pt-Pd didn't correspond to any of the pure metals and the characteristic plasmon band of silver decreased considerably when Pt-Pd was deposited on silver, suggesting the formation of core-shell structures. The electrocatalytic properties for the oxygen reduction reaction (ORR) were studied in 0.5M H_2SO_4 solution using the cyclic voltammetry (CV) and thin-film rotating disk electrode (TF-RDE) techniques. CV results indicate that when the metal loading on carbon particles increases, the voltammograms and particularly the peak intensities associated to ORR around of 700mV increase, however the electrochemical double layer region remained almost constant with values of 9-10mF/cm^2. The results using TF-RDE show that both the kinetics parameters as the activity, increase when increase the metal load and that the catalysts promote predominately a four-electron pathway for ORR. Although in general, the kinetic and activity were minors compared with commercial catalyst, the novel Ag/Pt-Pd core-shell electrocatalyst with 20% weight had about 4.5 times less activity but with 6.5 times less amount of platinum, that which represent 1.6 times more mass activity (current for milligram of platinum) compared with commercial catalyst. This obtained results demonstrate that the kinetic and activity is directly related to the metal loading and that a higher performance with very low amount of platinum for the ORR of the novel Ag/Pt-Pd core-shell electrocatalyst could be expected.

red with those of Pt/C.