Degradation analyses of MEAs and their correlations to fuel cell performance of $Ru_{85}Se_{15}$ cathode catalysts

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The carbon supported $Ru_{85}Se_{15}$ nonoparticles were synthesized by microwave assisted polyol method. The catalyst coated membrane method with ultrasonic-spray technique without hot press step was employed to prepare membrane electrode assemblies (MEAs) consisting of commercially available Nafion 212 membrane, carbon blacks (XC-72R) supported platinum (Pt/C) as an anode catalyst and carbon or multi-wall carbon nanotubes (MWCNTs) supported $Ru_{85}Se_{15}$ ($Ru_{85}Se_{15}$/C) as a cathode catalyst. A series of accelerated degradation tests (ADTs) were carried out by variations of Nafion contents and Ru loads in both H_2/air and H_2/O_2 fuel cells at 65^oC under ambient pressure. Very severe losses of 80% and 82% in maximum peak power densities were found for the 20% and 43% Nafion contents, respectively, while relatively moderate losses of 57% and 64% for the 0.14 and 0.61 mg Ru cm^{-2}, respectively. The best cell performances were achieved with 33% Nafion and 0.27 mg Ru cm^{-2}. The degradation behaviors of $Ru_{85}Se_{15}$/C are discussed based on the detailed analyses of cathode catalyst layers and membranes in MEAs before and after the ADTs. The dissolution and migration of Se/Ru and the corrosion of carbon support from the catalyst, together with the shrinkage and release of sulfonic acid from the membrane were identified and correlated to the decayed cell performances.