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**Nano-enabled catalysts for low temperature Fuel Cells**

Fuel cells operating below 100 ºC are very attractive energy conversion technology for automotive applications due to their higher efficiencies and higher peak power density values. Nanocatalysts for both alkaline and proton exchange membrane fuel cells will be discussed in this key note address. In general, the catalyst materials in the low temperature fuel cells are Pt or Pt-transition metal alloys on carbon or multi-walled carbon nanotubes. In the cost point of view there is a huge interest in developing fuel cell electrodes with non-noble metal catalysts towards oxygen reduction reaction (ORR). Iron phthalocyanines (FePc), cobalt phthalocyanines (CoPc) and other similar M-N4-macrocycles supported on different carbon nanomaterials have attracted much attention towards ORR in alkaline medium since 1960s. The aim of research was to develop FePc/MWCNT and CoPc/MWCNT electrocatalysts as alternative cathode materials to Pt/C in alkaline fuel cell. The fuel cell performance of the membrane electrode assemblies (MEA) with Co and Fe phthalocyanines and Tanaka Kikinzoku Kogyo Pt/C cathode catalysts were 100, 60 and 120 mW cm−2 using H2 and O2 gases.

The significantly high platinum loading on MEA for proton exchange membrane fuel cells (PEMFCs) limits the commercial viability. This research clearly describes the formation of Pt nanoparticles and characterizing them by electrochemical methods for fuel cell applications. When the Pt catalyst particle size is < 3 nm, the degradation of MEA is increased dramatically, especially towards ORR. Pt nanocatalyst on MWCNTs) functionalized with citric acid (CA) was synthesized by using a two-phase approach to transfer PtCl62− from aqueous to organic phase and self-assembly method of Pt-thiol ligand. Pt/MWCNTs with 3 nm particle size possess high ESA and durable characteristics. Cyclic voltammetry scan results show the high ESA of Pt/MWCNTs as compared to that of Pt/MWCNTs. As expected, the PEMFC performance with Pt/MWCNTs reached a power density of 1330 mW.cm-2 with H2/O2 gases at 80 oC, significantly higher than that of Pt/C. The activation loss of Pt/WMCNTs is much less than that of Pt/C. Using potential cycles between 0.1 and 1.2 V, it is evident that the Pt/MWCNTs with stable ESA values even after 1500 cycles could be very stable in the PEMFC durability.