Electrochemical stability investigation of TiO$_{x}$N$_{y}$ electro-catalyst produced by in-situ urea-based sol-gel method for PEM fuel cell application

A. Seifitokaldani*,1,*, A. Perrier*,1, O. Savadogo*,1,2
1Chemical Engineering Department, Polytechnique Montréal, Montréal, QC, Canada.
2Laboratory of New Materials for Electrochemistry and Energy, Polytechnique Montréal, C.P.6079, Succursale Centre-Ville, Montréal, Québec H3C 3A7, Canada

Despite, platinum supported on carbon (Pt/C) is the most used electro-catalyst for the Oxygen Reduction Reaction (ORR) in PEM fuel cells, problems such as sintering, dissolution of Pt in the electrolyte and oxidation of the carbon support during long-term operation are obstacles limiting the mass utilization of PEMFCs. The low abundance of Pt natural resources and its high cost are also limiting its utilization in high volume production of fuel cell cars (1, 2). Therefore, finding a new cheaper non-noble electro-catalyst with high activity and high stability in acidic condition becomes one of the most important topics in the PEMFC research. Development of transition metals oxy-nitride is an interesting approach for new electro-catalysts development for the ORR. Due to its high abundance, titanium oxy-nitride (TiO$_{x}$N$_{y}$) is one the most appealing electro-catalysts for the ORR (3-6).

In this study, TiO$_{x}$N$_{y}$ was prepared by a new in-situ urea-based sol-gel method. For comparison three other titanium oxide-nitrides were prepared using classical sol-gel method without urea. This electro-catalyst showed interesting activity for the ORR with an onset potential of ca. 0.75 volts vs. NHE. As well, exchange current density of the electro-catalyst prepared in in-situ urea-based sol-gel method was one order of magnitude higher than that of other electro catalyst obtained by another method. In addition, SEM pictures and BET surface area characterization showed a very small particle size (ca. 20–60 nm) with a BET surface area of ca. 93 m$^2$/g. This electro-catalyst represents higher stability than the commercial Pt/C based electro-catalyst.

**Figure 1.** Polarization curves before and after oxidizing the catalyst of TiO$_{x}$N$_{y}$ in 0.5 M H$_2$SO$_4$ at 25 °C

**Figure 2.** Cyclic Voltammetry with 100 mV/s scan rate of TiO$_{x}$N$_{y}$, in 0.5 M H$_2$SO$_4$ at 25 °C

**Figure 3.** Ti concentration measured by ICP-TOF-MS in H$_2$SO$_4$ 0.5 M at 25 °C