IPID4all Doctorate Research Exchange with NEXT ENERGY (Carl von Ossietzky Universität.

Feedback report

Hector Zamora, Chemical Engineer
University of Castilla La Mancha,Ciudad Real (Spain)
Dr. Justo Lobato
NEXT ENERGY
Fuel Cell division
Peter Wagner

27 April – 28 July 2016
Testing of Pt-Co based catalyst in High Temperature PEM Fuel Cells

Introduction

The development of new catalysts is one of the most interesting points in the improvement of HT-PEMFCs, focusing the study in two concrete fields: in first place, the improvement of the support in order to achieve enhanced service lifetime and performance, and on the other hand, the reduction of the platinum amount, which supposes a considerably decreasing of the production costs and new catalyst supports. On one hand, these new catalysts supports are expected to avoid rapid degradation of the catalyst, due to the hot acidic conditions of the fuel cell and the carbon electrochemical corrosion promoted to the high voltages achieves in the start-up and shut down processes. During the PhD, different materials have been evaluated to substitute the well stablished or common used Vulcan carbon as catalyst support, being carbon nanofibers platelet (CNFp) and SiCTiC with 10% mol. TiC content the materials with best promising results achieved, in terms of durability and performance, used as supports for Pt based catalysts. In this work, trying to reduce of the platinum amount, the main objective is the evaluation of two binaries PtCo based catalysts supported on the CNFp and SiCTiC materials mentioned above, studying the performance and electrochemical activity (focused on the Oxygen Reduction Reaction – ORR) of the catalysts to be used on the cathode side of HT-PEMFCs. Also, preliminary short term testing were performed using this catalyst in a single cell system during 235 hours + 60 hours of break-in, performing 5 characterization test during the experiments in order to evaluate the behavior of these novel catalyst in real operational conditions.

Research Undertaken

RRDE results show that bimetallic catalysts present lower active surface area than Pt/C catalyst, due to the blocking of active centers performed by the cobalt and cobalt oxides species. HOR tests show that PtCo/SiCTiC and PtCo/Vulcan catalysts are slightly better than Pt/C in terms of number of electrons transferred in the reaction, which makes these catalysts promising materials to be used in the anode side too. Respect to the preliminary short term testing, PtCo/SiCtiC based MEA shown a promising result (around 49 $\mu V\ h^{-1}$), with the same degradation rate that standard Pt/C MEA (around 48 $\mu V\ h^{-1}$) having lower Pt concentration, and its performance, lower than standard MEA, achieved acceptable values (550 mV at 0.3 A cm^{-2}). Further studies must be performed in order to optimize this catalyst (Pt:Co ratio, treatments after synthesis process, improving of the SiCTiC support to increase its porosity and/or electrical conductivity values…) in order to overcome the performance of this material. On the other hand, PtCo/CNFp based MEA exhibited the worst performance and the highest voltage drop value (224 $\mu V\ h^{-1}$) of the three MEAs evaluated, which means that support have a strong effect on the properties and behavior of the catalysts. Nevertheless, further fuel cell studies must be carried out with PtCo/C catalyst at cathode to evaluate the effect of the support on the fuel cell stability.

IPID4all Doctorate Research Exchange with NEXT ENERGY (Carl von Ossietzky Universität.

Feedback report

Personal Experience

This internship was an enriching experience from the research and personal points of view. In first place, I received much help and answer to all questions I had before to start the internship. The city was very nice, near to cities like Bremen or Hamburg, which allow myself to visit amazing places. Also, the Carl von Ossietzky Universität has a good dining room, which made easy the eating during the internship time. People was really nice, and I could know much people. Regarding to the research experience, it was very useful for my PhD. I could learn how to perform different analysis techniques, and also how to obtain additional parameters from the techniques I usually apply during the fuel cell and catalyst characterization. Also, this internship allow me to know different ways to work, protocols, work environment, and also to practice English and German with people. The only bad point was I had not enough time to perform all experiments I wanted to do. Definitely I recommend this experience for all people.

Conclusions

- PtCo based catalysts exhibit lower EASA than Pt/C, but similar activity through the ORR and HOR.
- PtCo based catalysts exhibit worse performance in terms of power density than pure Pt catalyst.
- PtCo/SiCTiC catalyst exhibit high electrochemical stability in the operational conditions of the HT-PEMFCs in case of the effect of the membrane is minimized. PtCo/CNFp exhibit the lowest performance, due to the degradation of the support and the low doping level of the membrane.
- It is necessary an additional >1000 hours long term test using the best PtCo based catalyst, in order to evaluate and understand better the degradation mechanism of the selected catalysts with more accuracy.

Outlook

- Due to the very good experience, probably during the next year, another partner of my home university will be sent to NEXT ENERGY to perform an internship to study Redox flow batteries, in order to improve the collaboration between both institutions.

Acknowledgements: This Internship, and the work performed during the same was supported by the German Academic Exchange Service (DAAD) with funds from the Federal Ministry of Education and Research (BMBF).

DAAD

Federal Ministry of Education and Research