Development of Ultra-Low Loading Pt/AGC Catalyst for PEM Fuel Cells

Taekeun Kim, Wonsuk Jung, Tianyuan Xie

and Branko N. Popov

Department of Chemical Engineering, University of South Carolina, Columbia, SC 29208

Activated graphitic carbon (AGC) [1-3] supported Pt catalysts were synthesized and their performance was evaluated under DOE potential cycling and potential holding conditions.

The goals are: (i) to achieve kinetic mass activity in H_2/O_2 fuel cell higher than the DOE 2017 target of 0.44 A mg_{PGM}^{-1}, (ii) to demonstrate durability of the kinetic activity per DOE cycling protocol between 0.6 and 1.0 V, and with performance loss less than 40% (iii) to accomplish high current density performance and durability in H_2/air fuel cell to meet 2017 DOE targets.

Cell diagnostics of the cathode catalysts such as ECSA, ORR mass activity, and oxygen polarization curves were performed after 5,000, 10,000, 20,000, and 30,000 cycles. The support durability was studied by applying 1.2 V vs. SHE constant potential with respect to the anode for 400 hours according to the DOE protocol. Cell diagnostics of the cathode catalyst such as ECSA, ORR mass activity, and oxygen polarization curves were performed after 100, 200, 300 and 400 hours.

Figure 1 shows mass activity loss of Pt/AGC during 400 hours potential holding at 1.2V. The mass activities were measure under DOE testing conditions [80 °C, 100% RH, H_2/O_2 (2/9.5 stoic.), 150 kPa_{abs}.]. The mass activity decreases from 0.15 to 0.10 A/mg after 400 h potential holding at 1.2 V (33% mass activity loss) which satisfied the DOE target (40% loss).

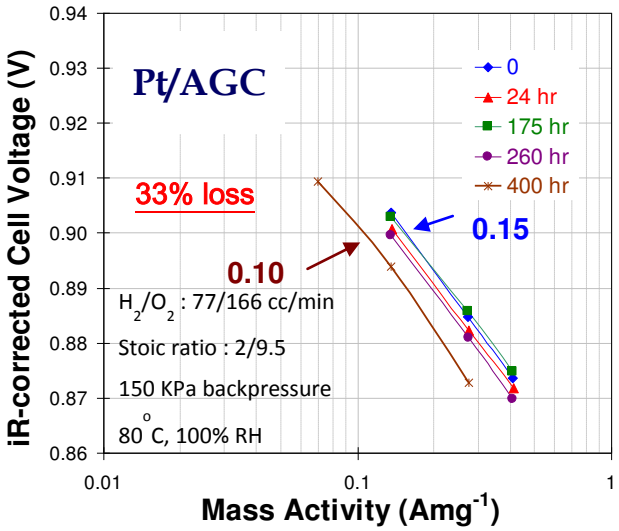

Figure 1. Mass activity loss of Pt/AGC during the potential holding at 1.2V for 400 hours.

Under H_2-air condition, the potential holding experiment at 1.2 V for the support durability of Pt/AGC showed only 12 mV loss after 400 hours indicating very stable support and catalyst (Figure 2). The observed voltage loss for Pt/C catalyst was higher than 250 mV after 25 h potential holding test at 1.2 V vs. SHE. Table 1 compares the support stability studies of Pt/AGC and Pt/C catalysts.

Detailed experimental results and theoretical studies on the Pt/AGC catalyst will be presented at the conference.

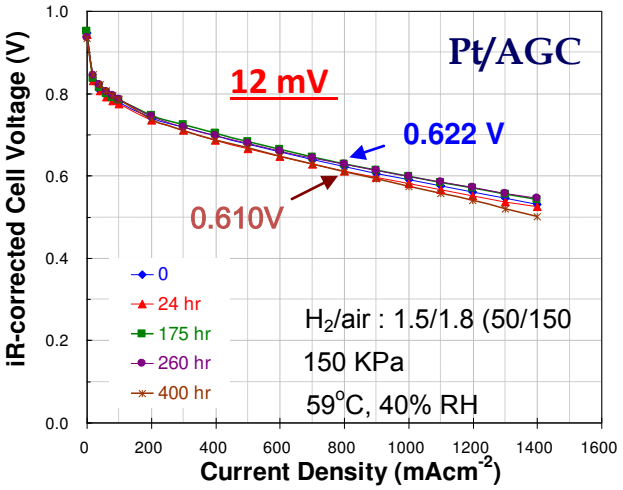

Figure 2. H_2-air fuel cell performance of the Pt/AGC during the potential holding at 1.2V for 400 hours.

Table 1 Support Stability Studies of Pt/AGC and Pt/C catalysts.

Testing		Pt/AGC	Pt/C (25h)
Mass Activity (A/mg)	Initial	0.15	0.18
	400h	0.1	0.08
	Loss (%)	33%	58%
ECSA (m^2/g)	Initial	58.8	-
	400h	40.2	-
	Loss (%)	32%	-
Voltage loss @0.8 A/cm^2 (V)	Initial	622	670
	400h	610	No activity
	Loss (mV)	12	-

References

[1] X. Li, B. N. Popov, T. Kawahara and H. Yanagi, J. Power Sources, **196**, 1717 (2011).

[2] G. Liu, X. Li, P. Ganesan and B.N. Popov, Appl. Catal. B: Environ., **93**, 156 (2009).

[3] N. Subramanian, X. Li, V. Nallathambi, S. Kumaraguru, H. Colon-Mercado, G. Wu, J.-W. Lee and B.N. Popov, J. Power Sources, **188**, 38 (2009).