PEM fuel cell electro catalyst using synergistic interaction among Pt, TiO_2 and carbon nanotube.

Yunseong Ji[1], Yongil Cho[1], Yukwon Jeon[1] Ho Jung Hwang[2], Oksung Jeon[1], Oh Chan Kwon[1], Jeong Pil Kim[1], and Yong-Gun Shul[1,2*]

[1]*Department of Chemical and biomolecular Engineering, Yonsei University, Seoul, Korea*

[2]*New Energy and Battery Engineering, Yonsei University, Seoul, Korea*

*E-mail: shulyg@yonsei.ac.kr

Fuel cell is one of the most promising electrochemical energy conversion devices which withholds many advantages; high efficiency, high power density, rapid start up, any significant pollutant, etc. Especially, polymer electrolyte membrane fuel cells (PEMFCs) get a lot of attention because it has high power density and is relatively portable. [1] However, still, there are many obstacles to commercializing fuel cells. In order to accelerate this, it is necessary to develop a catalysts with highly active and durable.

Pt/C catalyst is usually used as an electro-catalyst in PEMFC. When it used as cathode catalyst, carbon corrosion and platinum dissolution are main problems that electrode structure collapse, active site loss and catalytic surface area loss.[2]

Recently, metal oxide supports have been reported as promising materials due to their excellent mechanical resistance and inherently higher stability. Among many candidates, titanium dioxide (TiO_2) support has an extraordinary stability under severe acidic atmosphere, which provides the possibility to directly use as a support material. [3] However, the low electrical conductivity and surface area hinder the direct apply to the PEMFC electrode.

In order to solve these problems at the same time, we prepared TiO_2 nanofibers by electrospinning method and platinum nanoparticles were deposited by microwave-assisted polyol method. Then, CNT was winded around the catalyst surface to boost up the electrical conductivity. Furthermore, Pt electronic structure can be modified by takes advantage of the strong synergetic interactions of TiO_2 nanofibers, Pt nanoparticles and winded-CNT. This structure influences on a decrease of the d-band vacancy of Pt due to electron transfer from the support, resulting in an improved oxygen reduction reaction.

Therefore, the cathode with the CNT modified Pt/TiO_2 nanofiber composite shows higher catalytic activity due to the elimination of the drawback associated with conductivity and enhanced electronic active structure. As from various PEMFC tests, our CNT-Pt/TiO_2 catalyst shows superior performance and durability, which is definitely distinguishable at high temperature condition of 120 °C and RH 40% compare to the commercial Pt/C.

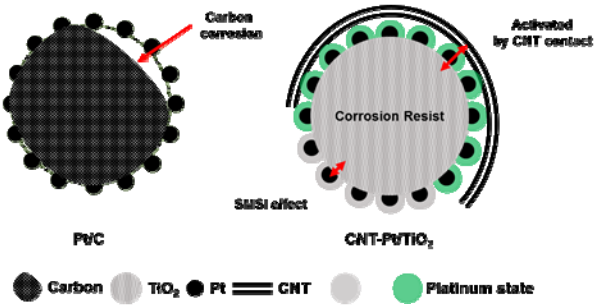

Fig. 1 Schematic diagram of Pt/C and CNT-Pt/TiO_2 catalyst.

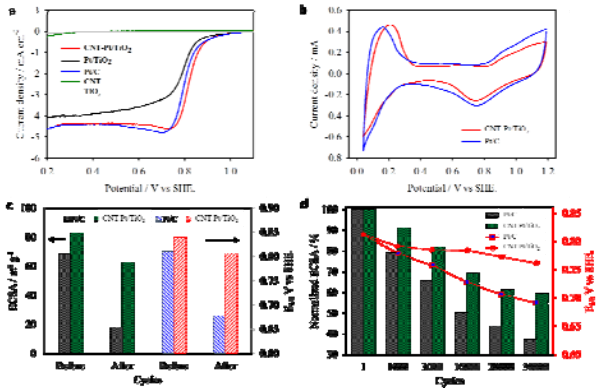

Fig. 2 Half cell (a) polarization curves, (b) cyclic voltammetry curves, and (c-d) result of durability test.

REFERENCES

[1] H.A. Gasteiger, N.M. Markovic, science, 324 (2009).

[2] Y. Shao, G. Yin, Z. Wang, Y. Gao, J. Power Sources, 167 (2007) 235-242.

[3] K. Sasaki, F. Takasaki, Z. Noda, S. Hayashi, Y. Shiratori, K. Ito, ECS Transactions, 33 (2010) 473.