

# Sulfur-stabilized PtFe nanocatalyst for oxygen reduction reaction in PEMFC

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Polymer electrolyte membrane fuel cell (PEMFC) is promising candidates for vehicle applications because of their high power density, quick startup, and high efficiency [1]. Despite their great potential as an efficient device for converting chemical energy directly into electric energy, deficient performance and durability of carbon-supported Pt catalysts and its high cost still need to be overcome in the development of electrochemical catalysts for widespread commercialization of PEMFC [2]. In response to these issues, one strategy to maximize the activity and durability of Pt toward the oxygen reduction reaction (ORR) is to make the core-shell structure by arranging the Pt alloy elements with different lattice parameters [3]. In this study, a novel strategy to prepare PtFeS ternary catalyst consisting of Pt shell on FeS core was investigated for enhancing the catalytic activity and durability toward ORR in the PEMFC.

Electrocatalyst of PtFeS nanoparticles on carbon support was synthesized via a modified polyol with  $\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$ ,  $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$  and  $(\text{NH}_2)_2\text{CS}$  and dealloying process in 1M nitric acid. For comparison purpose, PtFe/C and Pt/C was prepared by the same procedures without S and Fe, respectively.

The microstructures of Pt catalyst and sulfur-stabilized PtFe catalyst were estimated by TEM analysis, as shown in Fig. 1a and 1b. It is observed that metal nanoparticles are uniformly distributed on the carbon support in the all catalysts. Although the average particle size of Pt and PtFeS catalysts is 3.1nm and 3.4nm, respectively, obvious difference in morphology can be observed. The morphology of Pt catalyst shows the spherical shape, while the morphology of the PtFeS catalyst exhibits a mixture of spherical and rod-like shape,

which was attributed that nanoparticles of PtFeS are horizontally overgrown at the edge of preformed nanoparticles by the decomposition of thiol compound [4].

Overlapping the element mapping of Pt, Fe and S EELS signal as shown in Fig. 1c validates the core-shell structure, which is indicating the formation of sulfur and iron atom-rich core and Pt-rich shell.

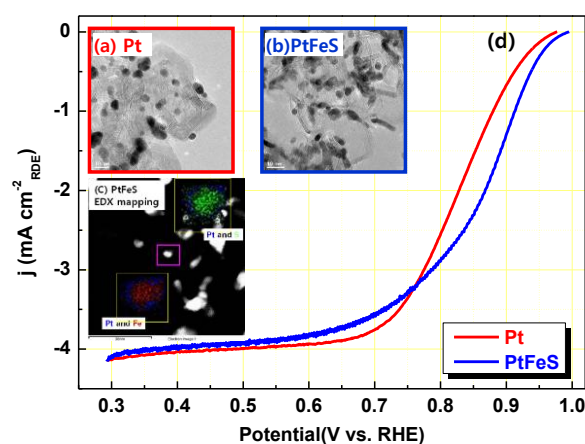


Fig. 1 TEM image of (a) Pt, (b) PtFeS, (c) EELS mapping of a single PtFeS nanoparticle and (d) ORR curve of Pt and PtFeS catalyst.

To investigate relation between core-shell typed PtFeS catalysts and the ORR activity, Fig. 1d displays the linear scan voltammetry of Pt and PtFeS catalyst in oxygen-saturated 0.1M  $\text{HClO}_4$  electrolyte with a scan  $5\text{m s}^{-1}$  at 900 rpm. The mass activity for the ORR of PtFeS catalyst is larger than that of Pt catalyst, which might be attributed to the modification of the orbital structure by Fe-S atom in core and the lattice-strain contraction by core-shell structure [5].

This synergistic combination of the alloy effect and the morphology control could provide the direction of development of Pt catalyst toward the ORR.

## REFERENCES

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