

# Enhancement of the ORR Activity of a Carbon Alloy Catalyst by Incorporating with Carbon Black

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# Introduction

## **Proton exchange membrane fuel cell (PEMFC)**

A promising power source for domestic supply and automobile

### **Advantages**

- High energy density
- Compact size
- Cleanliness
- Low operation temperature

### **Disadvantages**

- Slow cathode reaction



**Platinum has been used, but it is really expensive.**

**Non-platinum catalysts are needed.**

**Nanoshell containing carbon is one of the candidates.**

# Nanoshell-containing carbon (NSCC)

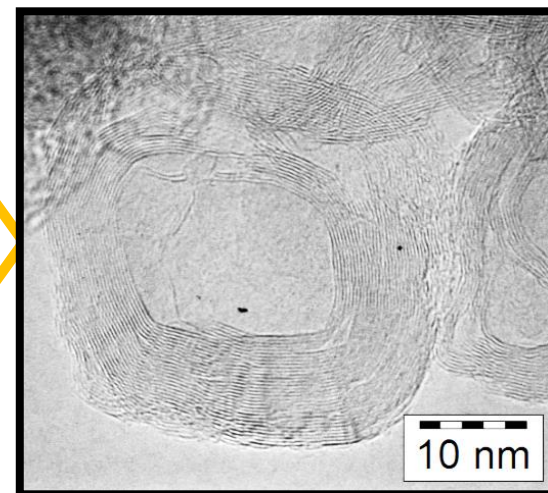
**Polymer**

**Metal complex**

**Graphite oxide**

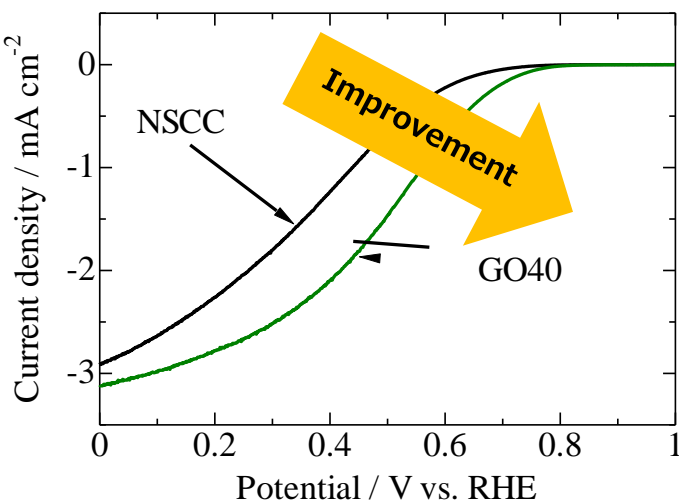
**Previous study**

**Carbonization**



**Oxygen reduction reaction (ORR) activity**

**Shell-like structure (Nanoshell : NS)**



## **Influences of graphite oxide addition\***

- Improvement of ORR activities
- Increase of nitrogen content
- Change of carbonization behavior

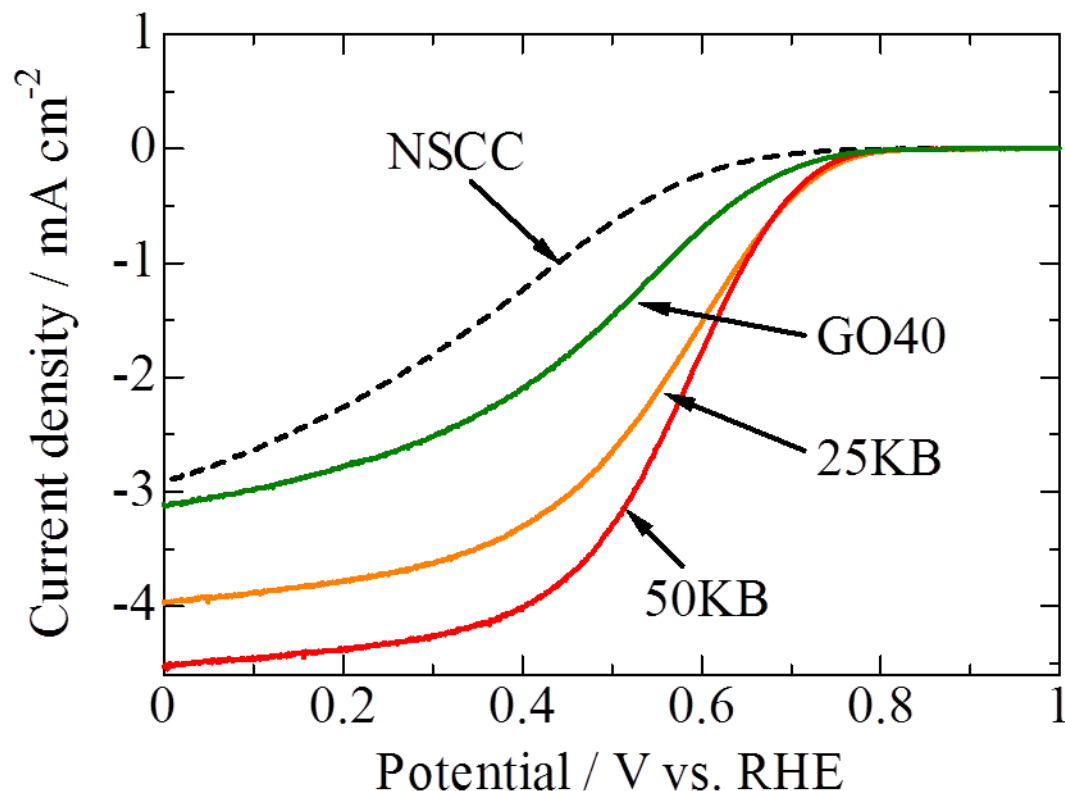
➤ Carbon black was used in the present study

# Objectives

To make clear the effects of the carbon black addition to a NSCC precursor on the following points :

1. The ORR activities
2. The surface elemental composition

# The influence of addition of KB on the ORR activities



Sample	$ i_{0.8} $ $\mu\text{A cm}^{-2}$
NSCC	3.1
25KB	26
50KB	17
40GO	14

\* $i_{0.8}$  : The current density at 0.8 V vs. RHE

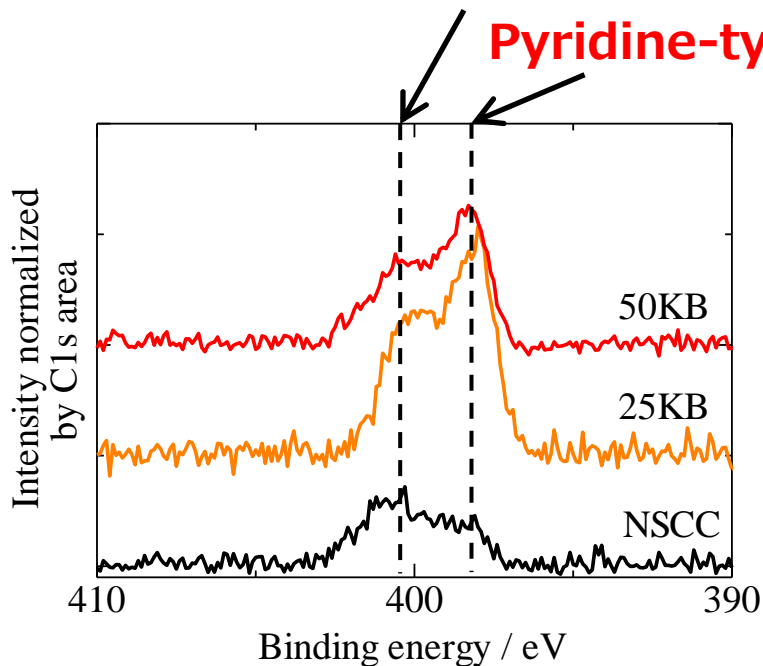
The  $i_{0.8}$  of the 25KB and 50KB were larger than that of the conventional NSCC and GO40.

- The addition of the KB to the precursor improved the ORR activities.

# The surface elemental composition

Pyrrole/pyridone-type (400.5 eV)

Pyridine-type (398.5 eV)



N 1s XPS spectra

Matter and Ozkan reported... \*

**“The pyridine- and the pyrrole/pyridone-type nitrogen were marker of the edge site.”**

The carbon layer incorporating nitrogen species was one of the candidates for active sites.

However...

The metal species was remaining on the surface of the 25KB and 50KB.

Sample	Atomic composition / at%			
	C	N	O	Fe
NSCC	89.6	0.58	9.9	0
25KB	93.5	1.64	4.7	0.2
50KB	88.6	0.98	10.4	0.06

\*P.H. Matter et al., *J. Catal.* **239** (2006) 83–96.

# Conclusions

The influences of the Ketjen black addition to NSCC precursor on the property of the resultant carbons.

1. Improvement of the ORR activities
2. Increase of nitrogen and iron species composition