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Presentation 13

ORR Activity Enhancement of Carbon Alloy Catalysts by Carbonaceous Additives

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Proton exchange membrane fuel cell (PEMFC) is a promising power source for domestic supply and automobile.

Advantages

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

Disadvantages

- Slow cathode reaction

$$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$$

So far, platinum has been used, but it is really expensive.

Non-platinum catalysts are needed.

Many types of non-Pt catalysts have been explored.
For example...

- **Metal chalcogenide catalysts**

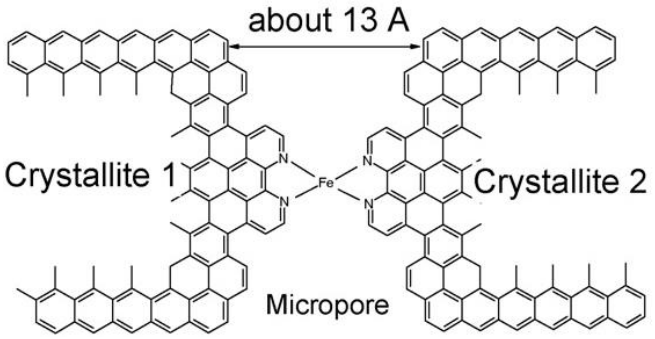
*G. A. Tritsaris, et al., *Electrochim. Acta* 56 (2011) 9783-9788.

- **Metal carbide-based catalysts**

*A. R. Ko, et al., *Appl. Catal. Gen*. 477 (2014) 102-108.

- **N_4 metal complex catalysts**

*F. Charreteur et al., *Energy Environ. Sci.* 4 (2011) 114–130.



N_4 metal complex catalysts

- **Carbon alloy (CA) catalysts**
  - **Nanoshell-containing carbon**

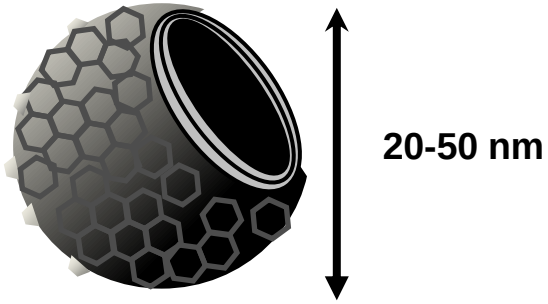
*J. Ozaki et al., *Electrochim. Acta.* 55 (2010) 1864–1871.

  - **N-doped carbon**

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

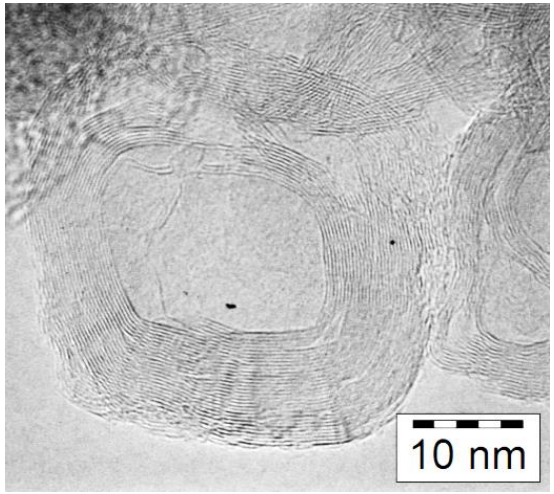
  - **BN-doped carbon**

*J. Ozaki et al., *Carbon* 45 (2007) 1847–1853.



Nanoshell carbon

What is nanoshell-containing carbons (NSCCs)?



- **Shell-like structure (Nanoshell : NS).**
- **Formed by catalytic carbonization.**
- **Oxygen reduction reaction (ORR) activity.**

Carbonaceous additives used

This additives was selected due to the following features of the materials.

Graphene oxide (GO)

- High hydrophilic
- High conductivity

(After pyrolysis)

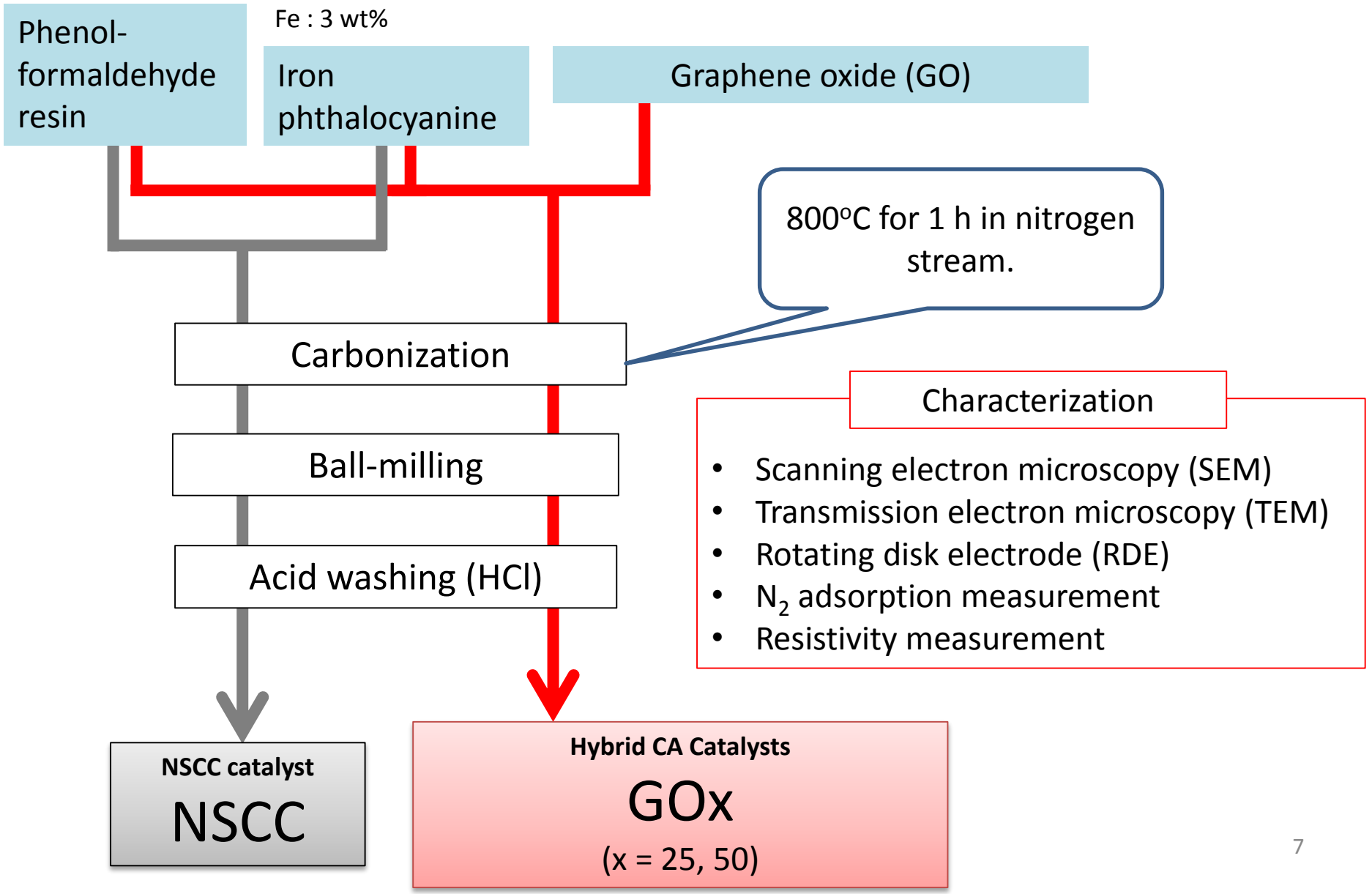
Objectives

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

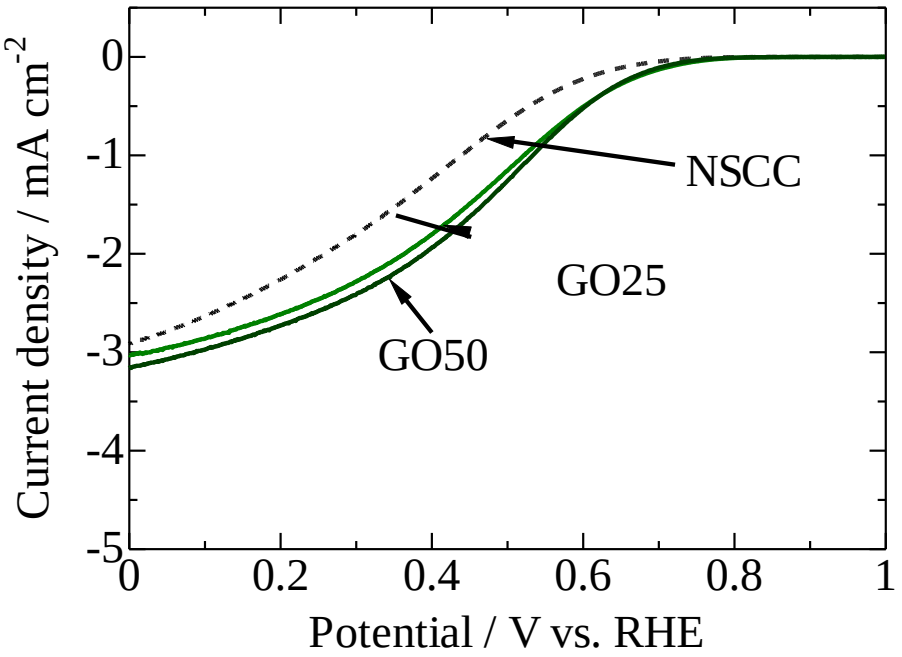
(1) The ORR activities of the CA catalysts.

(2) The major factor of the ORR activity.

Preparation process of Hybrid CA Catalysts



ORR activity



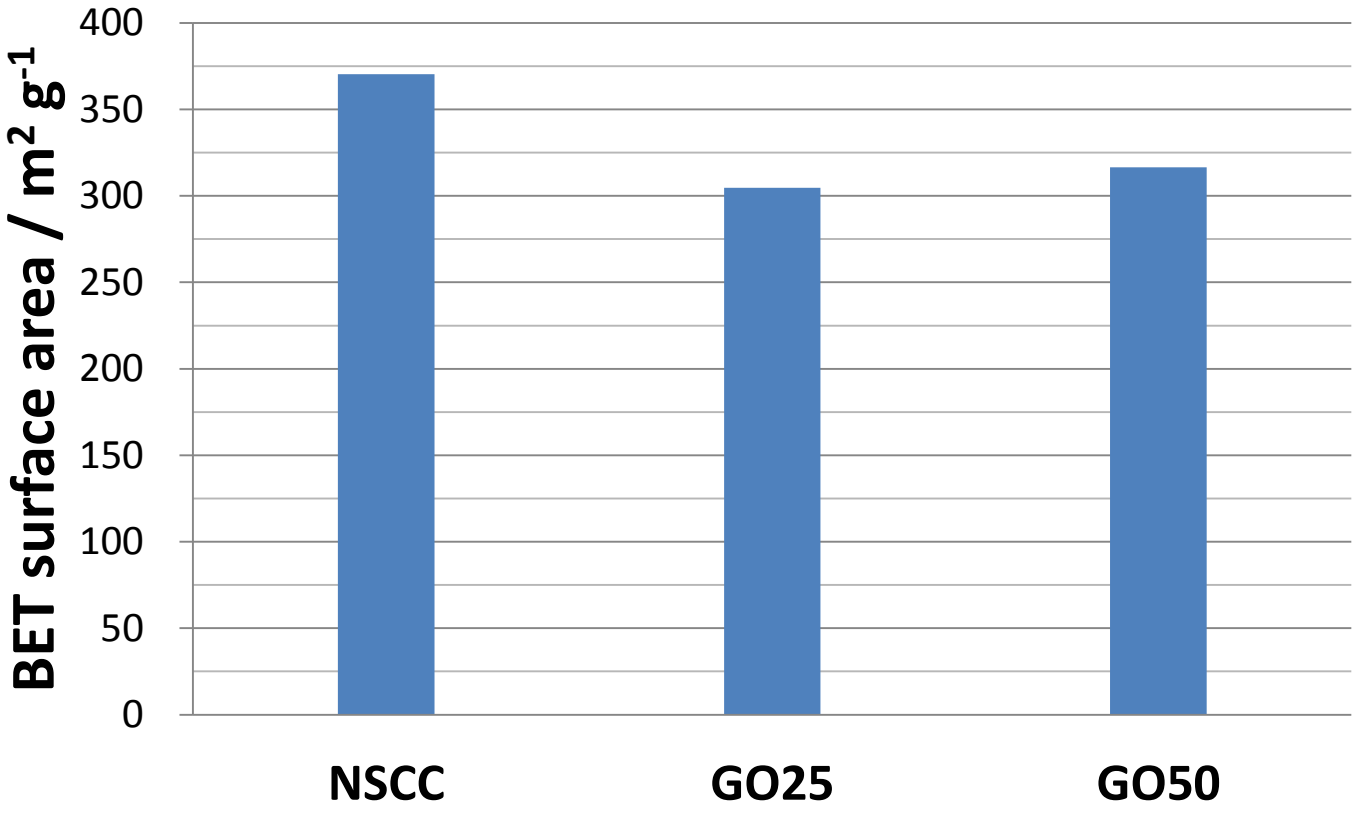
GO-series showed higher ORR activities than NSCC.

Possible factors to control the ORR activity

(1) Surface area

(3) Manner of contact

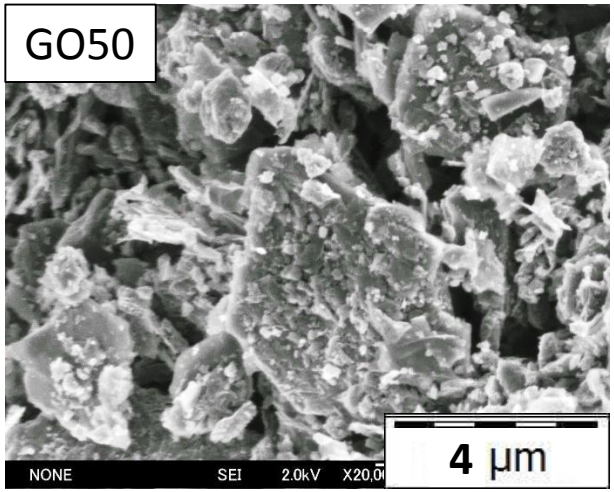
Surface area



The BET specific surface areas was not changed by the amounts of the additives.

BET surface areas can be a the major factor of ORR activities

Manner of contacts



GO-series : Flake structure derived from GO. Thick coating.

The ORR activities depended on the manner of contacts.

Conclusion

Investigate the influence of addition of Carbonaceous additive on the ORR activity and the structure of carbon catalysts.

1. **Influence of carbon addition on the ORR activity.**
   - **GO enhanced ORR activities of CA catalysts.**

2. **Influence of carbon addition on the structure.**
   - **The manner of contact surface areas depended on type of additives.**