

# ELECTROCHEMICAL PROPERTIES OF IRON-COATED CARBON MATERIALS FOR IRON-AIR BATTERY ANODE

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## Introduction

An increasing interest has been devoted in recent years to the metal/air battery due to its potential high energy density. Iron has been studied as a candidate for the anode material of metal/air battery [1, 2]. However, a large overvoltage of  $\text{Fe}/\text{Fe}^{2+}$  redox and a hydrogen evolution from its surface inhibit the practical use of iron for this purpose. The authors previously reported that the iron/nano-carbon composite electrode showed an improved charge-discharge performance [3]. In preparing such composite materials, it is preferable that the contact between iron and carbon is in a large extent. In the present study we have prepared iron-coated carbon materials using various carbon materials to prepare a novel iron/carbon composite electrode.

## Experimental

Acetylene black (AB, average diameter 100 nm; Denki Kagaku Co.) and vapor-grown carbon fiber (VGCF, average diameter 200 nm; Showa Denko Co.) was selected for this study. The iron-coated carbon material was prepared by coating iron on carbon as follows;  $\text{Fe}(\text{NO}_3)_3$  was impregnated on carbon from an aqueous solution and the mixture was calcined 1h at  $400^\circ\text{C}$  in Ar flow. Obtained iron-coated carbon material was observed by scanning electron microscope (SEM) together with electron dispersion spectroscopy (EDS).

Cyclic voltammetry (CV) were carried out with a three-electrode glass cell with Fe/C composite as the working electrode, silver oxide as the counter electrode and  $\text{Hg}/\text{HgO}$  as the reference electrode. The electrolyte was  $8 \text{ mol dm}^{-3}$  KOH aq. Scan rate was  $0.5 \text{ mV s}^{-1}$ .

## Results and discussion

SEM images and EDS results of iron-coated AB and Fe/AB composite electrode are shown in Fig 1. By coating iron on carbon, iron was more distributed on the surface of carbon than case of mixing Fe and C. Such distribution provides the larger contact between iron and carbon.

Fig. 2 shows the cyclic voltammograms profiles of iron-coated AB electrode and Fe/AB mixed electrode (a) and iron-coated VGCF and Fe/VGCF composite electrode (b), respectively. The ratio of iron to AB or VGCF was 1: 8. In both cases, several peaks were observable, including  $\text{Fe}^0/\text{Fe}^{2+}$  redox couple around  $-1.0 \text{ V}$  (reduction) and around  $-0.7 \text{ V}$  (oxidation), and also an irreversible reduction peak around  $-1.2 \text{ V}$  attributed to hydrogen evolution. The  $\text{Fe}^0/\text{Fe}^{2+}$  redox peaks from iron-coated AB and iron-coated VGCF electrodes were larger compared with corresponding mixed electrodes. In case of using AB the redox current was decreased with the repeating cycle. The situation was opposite when using VGCF. However, iron-coated AB shows larger current amount than iron-coated VGCF electrode. The large current of iron-coated AB may originate from the better contact between iron

and AB due to the more distribution of iron on the AB. In addition, the surface area, for which AB is 10 times larger than VGCF, may affect on electrochemical properties of iron-coated carbon material.

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## References:

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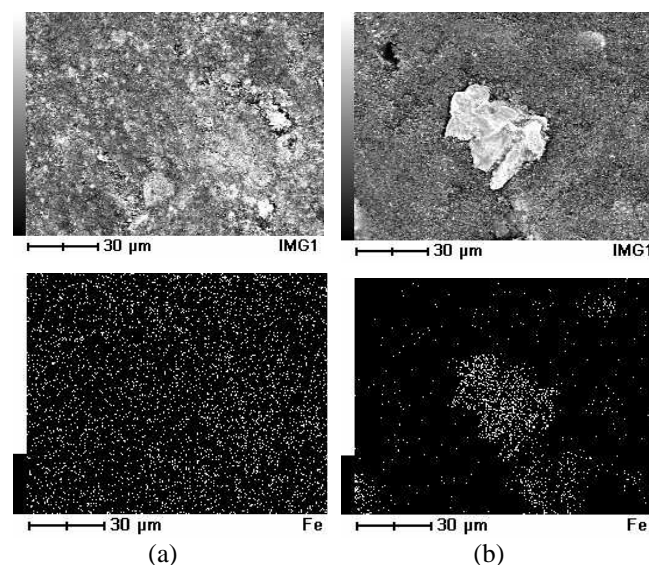


Fig 1. SEM images and EDS results of iron-coated AB (a) and Fe/AB composite (b) electrode. Fe:C=1:1

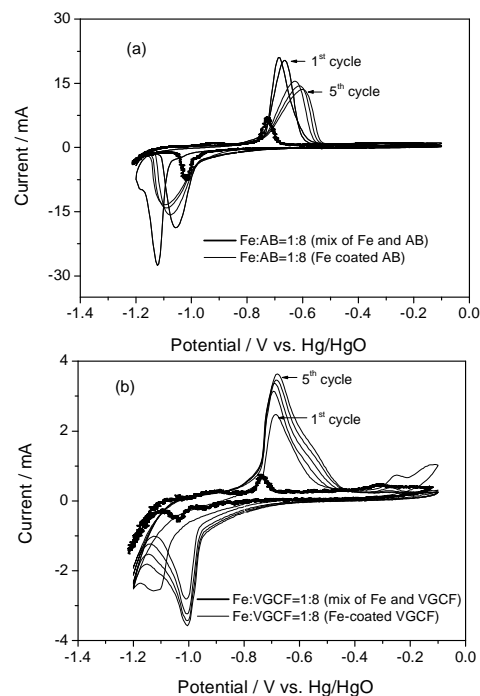


Fig 2. Cyclic voltammograms of (a) iron-coated AB and Fe/AB composite electrode and (b) iron-coated VGCF and Fe/VGCF composite electrode.