

Catalytic Activity of Au Monolayers Deposited on Metal Nanoparticles for the Oxygen Reduction Reaction in Alkaline Media

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Due to increasing number of fossil fuels powered vehicles, there is growing concern about fossil fuel availability and related environmental effects. Fuel Cells are strong candidates to replace internal combustion engines in automotive applications because they operate with higher efficiency, are light weight, can operate at low temperatures, and have fast start-up capability.

Alkaline fuel cells represent an attractive alternative to acid fuel cells for automotive application [1-3], because alkaline environment offers two advantages. First, the reduced adsorption of specifically adsorbed anions in alkaline solutions generally accelerates electrocatalytic reactions (oxygen reduction reaction (ORR), and the oxidation of organic molecules) [4-7]. Second, due to its less-corrosive nature, catalysts may be selected advantageously from a much wider range of materials, some of them non-noble.

A series of experiments were conducted in order to determine the ORR activity of Au monolayers (Au_{ML}) deposited on different substrates in 0.1 M KOH. For that purpose several M@Au ($\text{M}=\text{Ag}, \text{Pd}$) core-shell nanoparticles were prepared. The carbon supported Ag (20 wt%) (Ag/C), Pd (20 wt%) (Pd/C), and Au (20 wt%) (Au/C) were used. Due to Au's high reduction potential, Au_{ML} was electrolessly deposited on Pd and Ag substrate.

The ORR studies on $\text{Au}_{\text{ML}}/\text{Ag}/\text{C}$, Fig. 1, show that the ORR activity and the reaction pathway were greatly influenced by Ag support. In contrast to the 2e^- -ORR process on Au/C, the $\text{Au}_{\text{ML}}/\text{Ag}/\text{C}$ shows the 4e^- -reduction. The onset potential is the same as for Au/C.

Figure 2 shows a high activity of Au_{ML} , negligibly lower than that of Pd. The number of electrons exchanged in the ORR is slightly less than 4, while the onset potential is the same as for Pd/C.

These observations suggest that the electronic effect plays important role in increasing Au_{ML} activity for both supports. Further analysis of these two systems, as well as the results with other supports, will be discussed at the meeting.

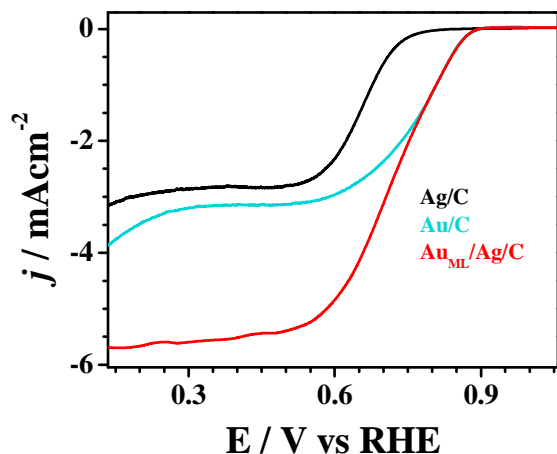


Figure 1. The ORR polarization curves for $\text{Au}_{\text{ML}}/\text{Ag}/\text{C}$, Au/C and Ag/C samples in oxygenated 0.1 M KOH at 1600 rpm with 10 mV/s scan rate.

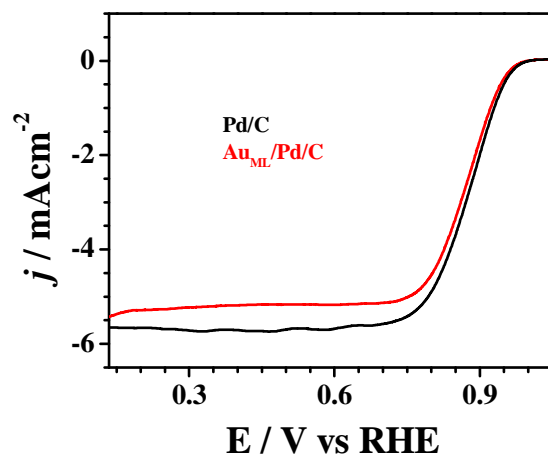


Figure 2. The ORR polarization curves for $\text{Au}_{\text{ML}}/\text{Pd}/\text{C}$ and Pd/C samples in oxygenated 0.1 M KOH at 1600 rpm with 10 mV/s scan rate.

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