

## Preparation and Characterization of PdAg Layer on Al<sub>2</sub>O<sub>3</sub> Substrate by Electroless Co-deposition

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### INTRODUCTION

In recent years, palladium based membranes have been received much attention for their applications in hydrogen separation and purification processes. A variety of methods were used to prepare PdAg film, such as sputtering, thermal evaporation, CVD and electroless plating. Among them, electroless plating is regarded as a promising technique due to the simple and low-cost operation. In this work, palladium and silver are co-deposited on the Al<sub>2</sub>O<sub>3</sub> substrate by electroless plating technique. The effect of Pd/Ag ratio on the surface morphology of the deposited layer was investigated. The nitrogen permeability of these composite membranes was also studied.

### EXPERIMENTAL

Prior to the electroless co-deposition, Al<sub>2</sub>O<sub>3</sub> substrates were prepared via activation and sensitization procedures. The composition of plating bath was listed in Table 1. The electroless plating was performed in a ultrasonic bath, and the temperature was kept at 333 K. After PdAg co-deposition, the composite membrane was dried at 393 K. The surface morphology of these composite membranes was observed by using SEM (JKA-840, JEOL Co.). Nitrogen permeation of these composite membranes was carried out at temperature of 573 K and pressure difference ranging from 100 kPa to 300 kPa.

### RESULTS AND DISCUSSION

According to the mixed potential theory, the plating rate of Ag was higher than that of Pd. Since the plating rate is different between Pd and Ag, the growth of PdAg grains can not keep the same rates for all directions resulting in the dendritic structure. As can be seen from Fig.1, it demonstrated that the addition of silver resulted in a dendritic structure of the PdAg layer. As the Pd/Ag ratios decreased, the dendritic structure was increased obviously. From the permeation results, the nitrogen permeability of the composite membrane was increased with decreasing the Pd/Ag ratio, as shown in Fig. 2. It revealed, as the silver content increased, large voids occurred in the dendritic structure of the PdAg layer and therefore led to a high permeability of nitrogen.

### CONCLUSION

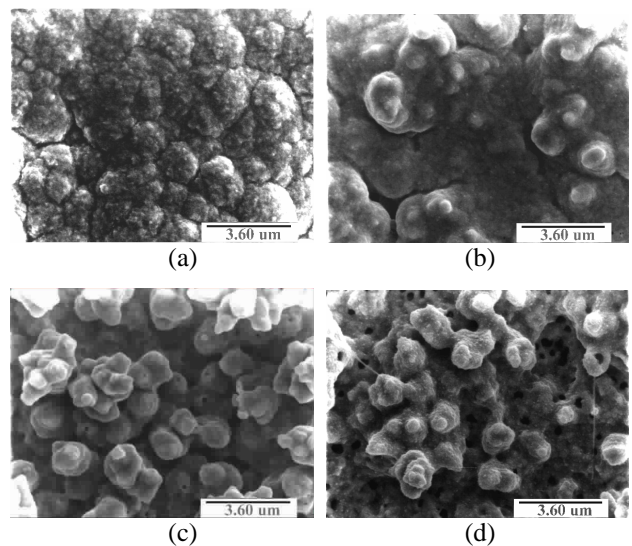
Increasing the Ag addition affected obviously the microstructure of PdAg deposit on Al<sub>2</sub>O<sub>3</sub> support resulting in a dendritic structure. The permeation results showed the dendritic structure was not dense and the nitrogen permeability increased with increasing the silver content. Based on the electrochemical theory, the dendritic structure was attributed to the different plating rates of Pd and Ag in the plating bath.

### ACKNOWLEDGEMENTS

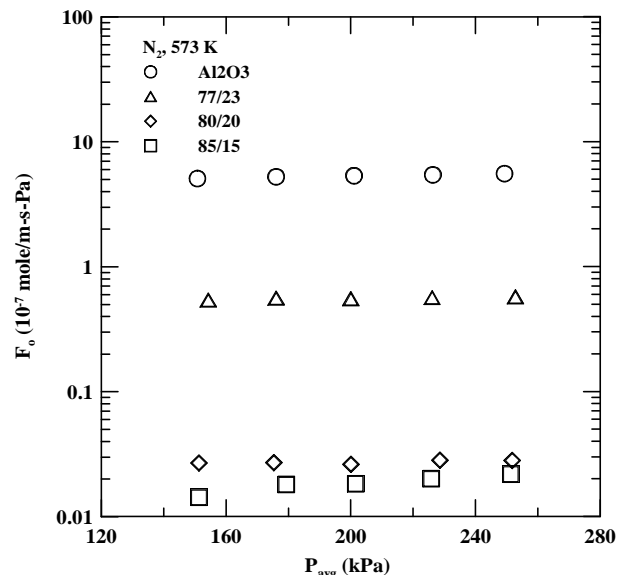
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**Table 1** The compositions of plating bath for PdAg co-deposition.

PdCl <sub>2</sub> (mM)	3.85-4.50
AgNO <sub>3</sub> (mM)	0.50-1.15
Na <sub>2</sub> EDTA (M)	0.16
NH <sub>4</sub> OH (28 %, ml)	200
N <sub>2</sub> H <sub>4</sub> (1M)	5
Buffer (ml/l)	100
Temperature (K)	333



**Fig. 1** SEM photographs of PdAg composite membranes by electroless co-deposition. Pd/Ag= (a) 100/0, (b) 85/15, (c) 80/20, (d) 77/23.



**Fig. 2** Effect of Pd/Ag ratios on the nitrogen permeabilities of the PdAg composite membranes.