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The Pt and the Pd-doped poly(vinylidene fluoride) Membranes for the Removal of Dissolved Oxygen from Water

Min-Joung Kim, Kew-Ho Lee*
Membranes and separation research Center, Korea Research Institute of Chemical Technology (KRICT), P.O. Box 107, Yusung, 305-600, Daejon, Korea

백금 및 팔라듐 촉매가 고정된 폴리비닐리덴플루오라이드막을 이용한 용존산소 제거

김민정, 이규호
한국화학연구원 분리막다기능소재연구센터

1. Introduction

The removal of dissolved oxygen (DO) from water is one of the primary concern in many industrial areas such as semiconductors, power plant, pharmaceuticals, and foods. In semiconductor industry, presence of the DO in ultra-pure water will result in a formation of a native oxide layer on the silicon wafer surface during the cleaning process. This native oxide layer hinder the development of more high-quality silicon thin films. In the power industry, corrosion in a boiler or steel pipes will be prevented if the DO level in the water is lower than 0.5 ppm[1,2]. Removal of dissolved oxygen from water can be achieved by either physical or chemical methods. Conventional physical methods such as thermal degassing, vacuum degassing have a disadvantage in terms of both operating cost and bulky construction. Conventional chemical methods using hydrazine and sodium sulphite are not suitable because of the toxicity of those chemicals. Catalytic reaction using hydrogen as a reducing agent is attractive method because it does not produce by-product to contaminate water. Li et al. have studied the removal of dissolved oxygen from water using a noble membrane reactor. The membrane reactor used was a polypropylene microporous

hollow fiber membrane with a commercialized palladium catalyst in the void space of shell side of membrane module[2].

In this study, we have prepared catalyst-doped membranes and studied the removal of dissolved oxygen from water using catalytic membranes. The asymmetric porous poly(vinylidene fluoride)(PVDF) membranes were prepared for development of Pt-doped PVDF membranes and the Pd-PVDF membranes. The influences of the catalyst content of the catalyst-doped PVDF membranes on DO removal from water have been investigated.

2. Experimental

The alumina-contained porous PVDF membranes were prepared by phase-inversion method. The immobilization of catalysts on alumina-contained PVDF membranes was achieved by impregnation-reduction method. Palladium precursor (Aldrich, USA) and platinum precusor(Aldrich, USA) were used. The hydrazine compound(Junsei, Japan) were used as a reducing agent. The morphology of the catalyst-doped PVDF membranes was investigated by SEM.

The experimental for removal of dissolved oxygen was carried out using flat-type membrane contactor cell. Hydrogen was used reductant in the catalytic reaction. Hydrogen was introduced into down-stream of membrane contactor and flow through the pore of catalytic membrane, while the water saturated with oxygen(DO level of 8 ppm) was fed into up-stream and flow through the membrane surface. A Neomet Model 29D dissolved oxygen meter was used to measure the concentration of dissolved oxygen in the water.

3. Results and discussion

The Pt-PVDF and the Pd-PVDF membranes have prepared for removal of dissolved oxygen from water. The porous Pd-PVDF membranes showed higher DO removal efficiency. The DO removal efficiency of the membranes was increased with catalyst content in the membrane. The DO removal efficiency of the porous Pt-PVDF membranes was in the range of 22.5~43.8% and increased with Pt catalyst content in the PVDF membranes. The DO removal efficiency of

the porous Pd-PVDF membranes was in the range of 33.8~98.8% and increased with Pt catalyst content in the PVDF membranes. It was found that the H_2 flow rate induced in the membranes could significantly influence the DO removal properties of the Pd-PVDF membranes.

4. Conclusions

In this study, we have prepared catalyst-doped membranes and studied the removal of dissolved oxygen from water using catalytic membranes. The Pd-doped PVDF membranes showed higher DO removal efficiency than those of Pt-doped-PVDF membranes. It was found that DO removal properties of the catalytic membranes depend on the catalyst content and the operating condition such as H_2 flow rate.

5. References

1. A. Ito, K. Yamagiwaa, M. Tamuraa, M. Furusawa, "Removal of dissolved oxygen using non-porous hollow-fiber membranes", J. of Membrane Sci., 145, 111 (1998).
2. K. Li, I. Chua, W. J. NG and W. K. Teo, "Removal of dissolved oxygen in ultrapure water production using a membrane reactor", Chem. Eng. Sci., 50(22), 3547 (1995).

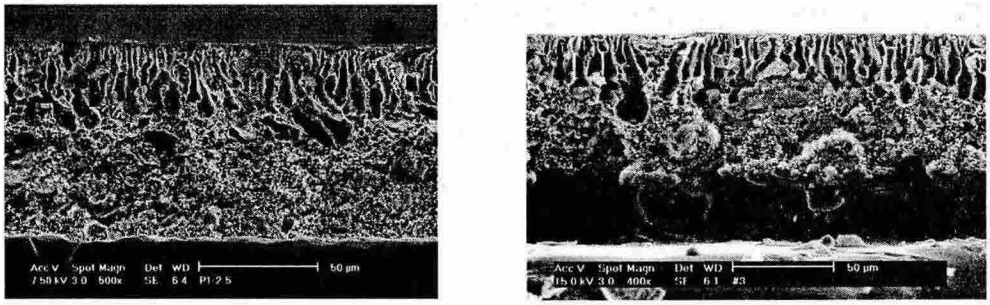

Figure 1. The SEM photographs of catalytic membranes.

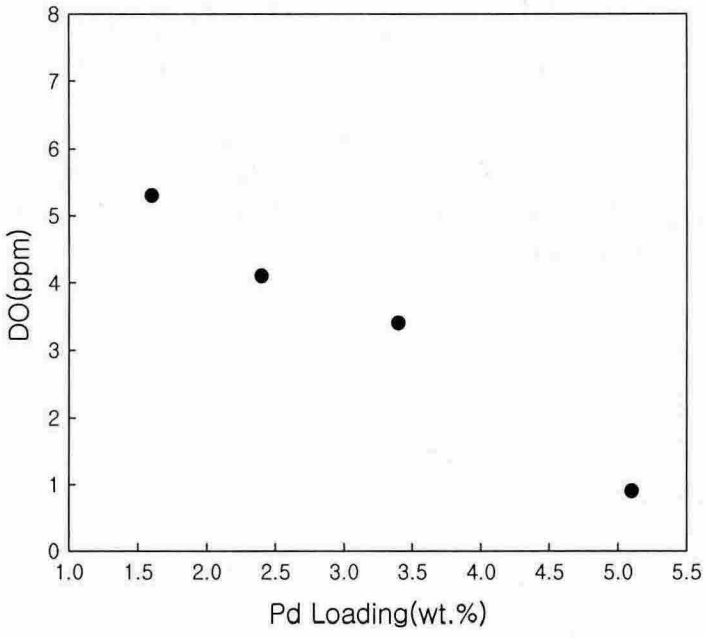

Figure 2. The effect of catalyst content on DO removal.