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Modification of Membrane Surface using ALD ZnO for Anti-Biofouling

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Extended Abstract

Biofouling by microorganisms is the most serious problem in membrane processes, as the microorganisms form a biofilm on the membrane surface, resulting in increased chemical and physical resistance. Depositing a metal oxide thin film having antibacterial activity on the membrane surface is an attractive approach to overcome the biofouling problem. However, a very thin and uniform film deposition technique is required to prevent the membrane pore clogging by metal oxide film itself.

Atomic layer deposition (ALD) is a new technology that deposits metal oxides uniformly with nanometer thickness on complicated structures [1], which can overcome the limitations of conventional deposition methods such as chemical vapor deposition and sol-gel method. This study aimed to investigate the antimicrobial effect of zinc oxide (ZnO) thin films formed by ALD and evaluate its applicability to the membrane surface.

A thin ZnO film was formed with an atomic layer deposition reactor using diethylzinc and deionized water as precursors and oxidants, respectively. Various thin ZnO films were formed by the number of repetition cycles, and its thickness was analyzed by field-emission scanning electron microscopy. [2] In addition, the permeability was compared between control membrane and modified membrane using a lab-scale filtration unit. The thin ZnO film was irradiated with UV-A light to induce the photocatalytic reaction, and the antimicrobial effect of the thin ZnO film was measured through the analysis of viability of Pseudomonas aeruginosa.

The thickness of the ZnO thin films formed by ALD increased from 10 to 40 nm in proportion to the number of deposition cycles. As the thickness was much thinner than the pore size of the microfiltration membrane (200 nm), the ZnO thin films could not substantially reduced porosity of the membrane. Furthermore, the ZnO thin films consisted of closely packed nano-sized hexagonal wurtzite crystalline structures which was helpful for the production of reactive oxygen species such as singlet oxygen, hydroxyl radical, and superoxide anion under UV-A irradiation. A filtration test demonstrated that the membrane coated with the ZnO thin films was more resistant to biofouling than that without the ZnO films. These results suggest that the membrane coated with ZnO by ALD could be an effective way in reducing biofouling without hampering filtration performance.

References

[1] S. M. George, "Atomic layer deposition: an overview," *Chem. Rev.*, vol. 110, pp. 111-131, 2010.
[2] K.-H. Park, "Antibacterial activity of the thin ZnO film formed by atomic layer deposition under UV-A light," *Chem. Eng. J.*, vol. 328, pp. 988-996, 2017.