Anodic Alumina-Mesoporous Silica Hybrid Membranes: A Systematic Study Of Alumina Filling

Silo Meoto, Marc-Olivier Coppens

Isermann Department of Chemical and Biological Engineering, Rensselaer Polytechnic Institute, 110, 8th Street, Troy, NY 12189 USA, E-Mail: meotol@rpi.edu

1. Introduction

Mesoporous materials with ordered arrays of uniform nanochannels of a controllable size have wide-ranging applications, one of which is membrane separation. In order to be used as a membrane for size-exclusive separation of molecules, it is necessary to synthesize a defect-free structure with continuous nanoporosity. Mesoporous silica and porous anodic alumina have been extensively used to prepare new hierarchically ordered structures [1]. Mesoporous silica, SBA-15, is a particularly attractive material, because of its advantageous properties including an ordered pore structure, a narrow pore distribution of controllable size between 2.5 to 30 nm, high thermal stability and a well-known silane chemistry for surface functionalization [2]. An anodic alumina membrane is a suitable substrate because it has pores of a well-defined orientation, which are aligned perpendicular to the surface. As a result, a uniform alumina-mesoporous silica membrane with perpendicularly oriented nanochannels can be used as a nanofluidic device for molecular separation.

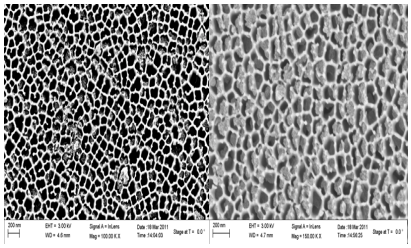

Fig. 1: SEM images of anodic alumina membrane after treatment with precursor solution using sol-gel method

However, the filling of the columnar pores of anodic alumina is not as easily attainable as literature suggests. A major issue in fabricating an alumina-silica hybrid membrane is realizing high inclusion of silica-surfactant nanocomposites inside the channels of the alumina membrane. We demonstrate this using two often used techniques, the sol-gel method [3] and aspiration [4], to fabricate alumina-silica hybrid membranes.

2. Conclusions

The fabrication of hybrid membranes with mesostructured nanotubal arrays of silica inside the channels of anodic alumina is reported. The techniques and synthesis conditions of precursor solutions were modified to achieve higher inclusion of silica-surfactant nanocomposites inside the alumina membrane with little or no formation of mesoporous silica on the external membrane surface. The as-synthesized hybrid membranes were characterized using scanning electron microscopy (SEM), nitrogen adsorption/desorption isotherms, and liquid permeation experiments. Our results illustrate the challenges of realizing a nanoporous membrane that is uniformly crack-free over

large domains, when using anodic alumina templating, combined with sol-gel and aspiration methods to grow silica inside the alumina channels.

References

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