Mesoporous Silica Thin Membranes Supported on Macroporous AAO Suitable for ppb-Level Nanoparticles Separation

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Abstract

With the extensive application of engineered nanomaterials in various industries, many had raised the concern of the release of nanoparticles into the environment which in turn causes nanotoxicity in living organism. This study overlaps an ultrathin selective layer of vertically aligned mesoporous silica thin film (MSTF) on anodic aluminum oxide (AAO) membrane which is intended to be use for the separation of nanoparticles. A thin layer of MSTF with low tortuosity, uniform vertical straight-through nanochannels, superhydrophilicity, and high porosity may be constructed utilizing the Stöber technique and surfactant-template assembly. It is worth noting that using a thin layer of polystyrene (PS) as a sacrificial layer allowed us to customize a mesoporous silica film on a macroporous AAO membrane. It is presented here that the significant features of MSTF⊥AAO membrane with pore diameter smaller than 5 nm have enabled it to perform well in separating nanoparticles mainly based on size-selectiveness. Moreover, with its surface hydrophilicity and perpendicular pores supported on the membrane, the as-prepared E-MSTF⊥AAO membrane possesses high permeance of around 114.1 ± 12.3 LMH/bar. For nanosized-based separation, both as-prepared D-MSTF⊥AAO and E-MSTF⊥AAO demonstrated excellent separation efficiency of around 99 % towards solution containing gold nanoparticles in ppm to ppb range. With its satisfying separation performance, it is believed that this MSTF layer has high potential to be applied in treating wastewater containing low concentration of nanoparticles, hence preventing contaminations from nanomaterials in our water sources.

References

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