

## Interfacial interaction induced mesostructural changes in nanocylinders

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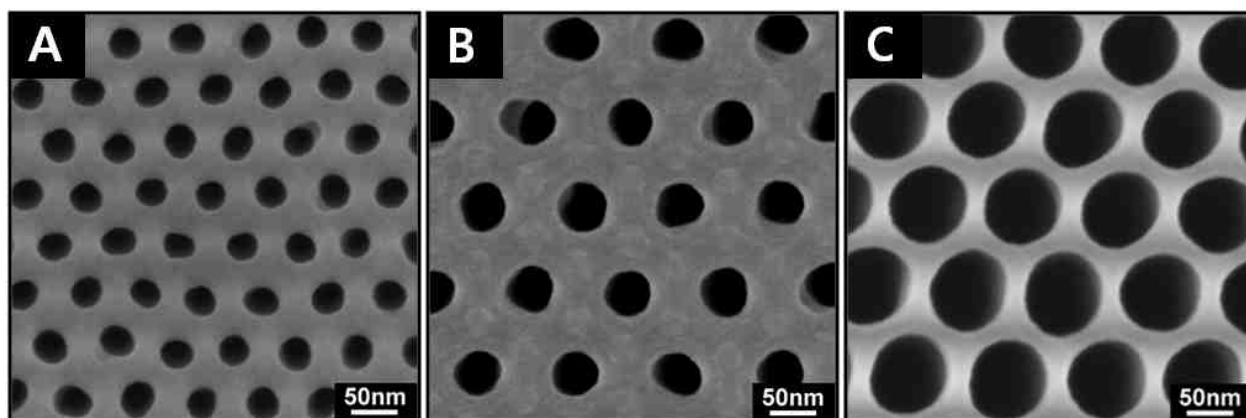
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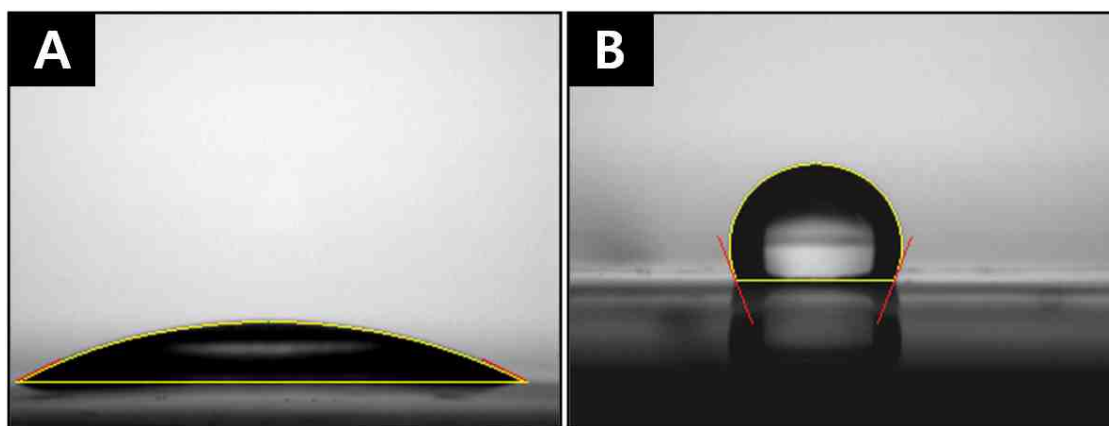
### Experimental Details

*Preparation and modification of porous alumina membrane (PAM).* The PAM membranes were electrochemically fabricated using high purity (99.999%, Aldrich) Al foils in 0.3 M oxalic acid (97%, Cica-Reagent) by two-step anodization [1]. The first anodization was carried out at 40 V d.c. for 12 h at 15–17 °C. After complete removal of the first generated porous alumina film, the second anodization was lasted for 6 h and then the as-grown PAMs were electrochemically detached from back Al foils at 45 V d.c. at 10 °C in the mixture solution of ethanol (99.9%, Burdick & Jackson) and perchloric acid (60%, DC Chemical) (1:1 v/v). To adjust cylinder diameter, the PAMs were dipped in 10 wt.% H<sub>3</sub>PO<sub>4</sub> (85%, Showa) solution for 10–30 min at ambient temperature, which resulted in the different cylinder diameters of 50 ± 3 and 83 ± 2 nm (Fig. S1). To prepare PAM with a smaller pore diameter, the second anodization was carried out in 0.3 M sulfuric acid (97%, Matsunoen Chemical) at 25 V d.c. for 6 h at 10 °C, which enables 34 ± 2 nm PAM after ~5 min pore widening process. The resulting as-made PAM membranes showed good water wettability with a contact angle of 6–26° (Fig. S2A).

For hydrophobic nanocylindrical environment, the as-made PAMs were chemically modified by treating with a chemical, 10 wt.% octadecyltrichlorosilane (90%, Aldrich) in toluene, through refluxing for 12 h, and then the resulting membranes were rinsed in successive volumes of toluene, ethanol, and deionized water. The resulting surface-modified PAMs have hydrophobic surface with a water contact angle of 104–111° (Fig. S2B).



**Fig. S1** Fabricated porous alumina membranes of different pore diameters of (A) 34 ± 2, (B) 50 ± 3, and (C) 83 ± 2 nm with a pore density of  $\sim 1 \times 10^{10}/\text{cm}^2$ .



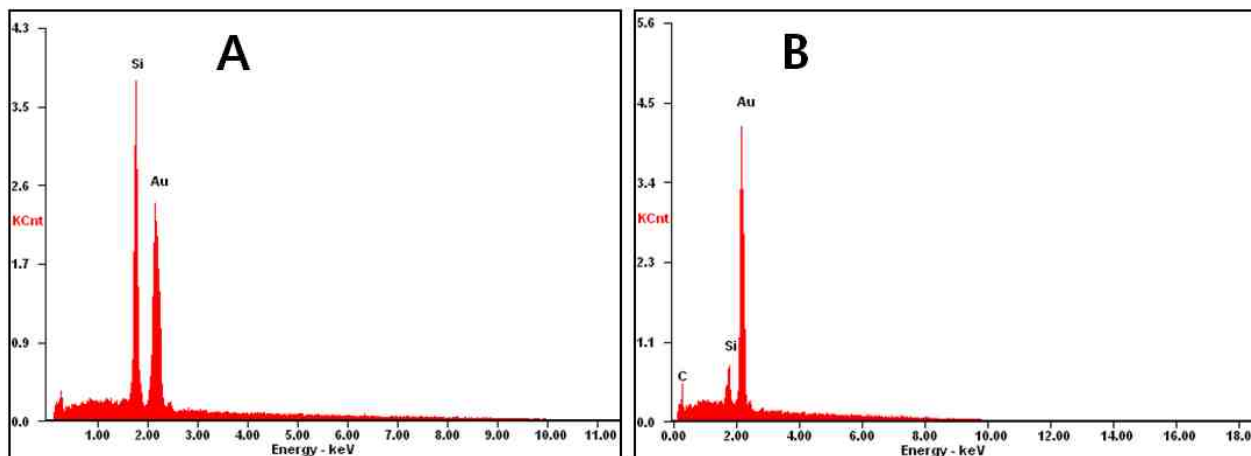
**Fig. S2** Water contact angle of (A) the as-made PAM and (B) the octadecyltrichlorosilane modified PAM.

*Loading mesostructured silica into the PAM nanocylinders.* The lyotropic mixture solution consisted of the silica source of tetraethylorthosilicate (TEOS, 98%, Sigma-Aldrich), poly(ethylene oxide)-b-poly(propylene oxide)-b-poly(ethylene oxide) block copolymer (Pluronic F127, EO<sub>106</sub>PO<sub>70</sub>EO<sub>106</sub>, 97%, Sigma), nitric acid (60%, Matsunoen chemicals), and ethanol was used in this study. The molar ratio of the precursor solution was 10 TEOS: 0.08 Pluronic F127: 0.1 HNO<sub>3</sub>: 50 ethanol. The PAM membranes with different pore diameters and different surface properties were dipped into the lyotropic precursor solution and kept for 48 h at room temperature to completely fill the nanocylinders with precursor solution. The lyotropic mixture infiltrated composite PAM membranes were taken out and allowed to gelation at 70 °C for 24 h, which were further calcined at 450 °C for 2 h. For the scanning and transmission electron microscope imaging, the mesoporous silica infiltrated PAM membranes were treated with 1 M HCl aqueous solution overnightly to remove the PAM host and then purified with deionized water repeatedly.

*Fabrication of porous gold (Au) nanofibers.* The composite PAM membranes including mesoporous silica were used as templates for electrochemical Au deposition. Thin Pt film was back-coated on the composite membrane using a sputter (Hitachi, E1030) in order to use as a working electrode. The deposition was carried out in the aqueous electrolyte including 0.02 M KAu(CN)<sub>2</sub> (98%, Aldrich) and 0.25 M Na<sub>2</sub>CO<sub>3</sub> (99%, Cica-Reagent) under a constant current mode (2.0 mA/cm<sup>2</sup>) in a two electrode system. The Au deposited composite membranes were treated with 10 wt. % HF (*Caution: toxic chemical*) to dissolve the composite templates consisted of silica and alumina. The resulting gold products were purified by applying repetitive suspension-centrifugation cycles to remove residual chemical species.

*Characterizations.* The resulting nanomaterials were imaged using a field-emission scanning electron microscope (FESEM, SU-70, Hitachi) equipped with an energy dispersive X-ray spectroscopy (EDX) system for elemental analysis. SEM imaging was typically operated at 1.5 keV in charge reduced mode for the porous silica insulating materials and at 5 keV for the gold nanomaterials. Transmission electron

microscope (TEM) images were measured using a microscope (JEM-2100F, JEOL) operating at 200 keV. Surface property was measured using a contact angle analyzer (Phoenix 300, SEO, Korea).



**Fig. S3** EDX spectra of the electrochemically-grown gold replicas using the mesoporous silica infiltrated composite PAM templates which are originating from the (A) as-made and (B) hydrophobic PAMs. The gold samples were dispersed on silicon wafers before analysis.

## References

- (1) (a) H. Masuda and K. Fukuda, *Science*, 1995, **268**, 1466; (b) O. Jessensky, F. Müller and U. Gösele, *Appl. Phys. Lett.*, 1998, **72**, 1173; (c) J.-K. Lee, W.-K. Koh, W.-S. Chae and Y.-R. Kim, *Chem. Commun.*, 2002, 138; (d) L. Malkinski, J.-H. Lim, W.-S. Chae, H.-O. Lee, E.-M. Kim and J.-S. Jung, *Electron. Mater. Lett.*, 2009, **5**, 87; (e) H.-O. Lee, E.-M. Kim, H. Yu, J.-S. Jung and W.-S. Chae, *Nanotechnology*, 2009, **20**, 325604.