ELECTRONIC SUPPLEMENTARY

INFORMATION

Fabrication and Design of Mechanically Stable and Free-standing Polymeric Membrane with Two-level Apertures

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Key words: Multiscale structure, Design rule, UV curable material, Free-standing membrane, Two-level apertures
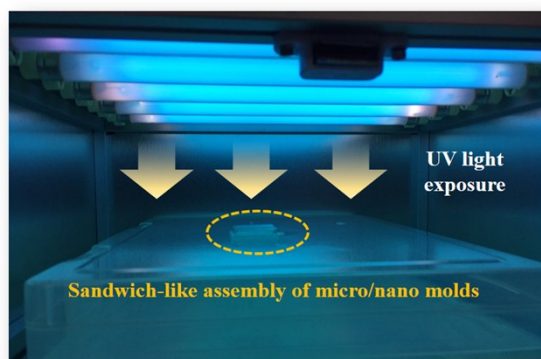
Figure S1. Camera image of Custom-built UV exposure equipment and UV exposure process to sandwich-like assembly of micro/nano molds.
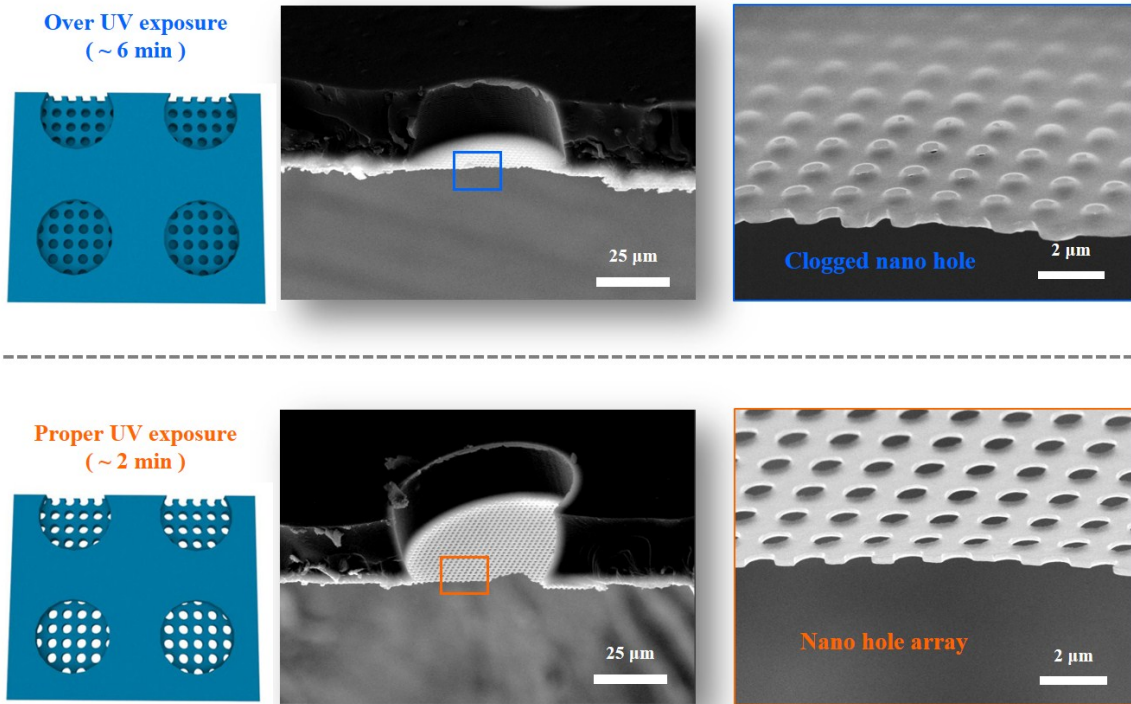
Over UV exposure (~ 6 min)

25 μm

Clogged nano hole

2 μm

Proper UV exposure (~ 2 min)

25 μm

Nano hole array

2 μm

Figure S2. SEM images of the fabricated polymeric membrane with two-level apertures with variation of UV light exposure time.
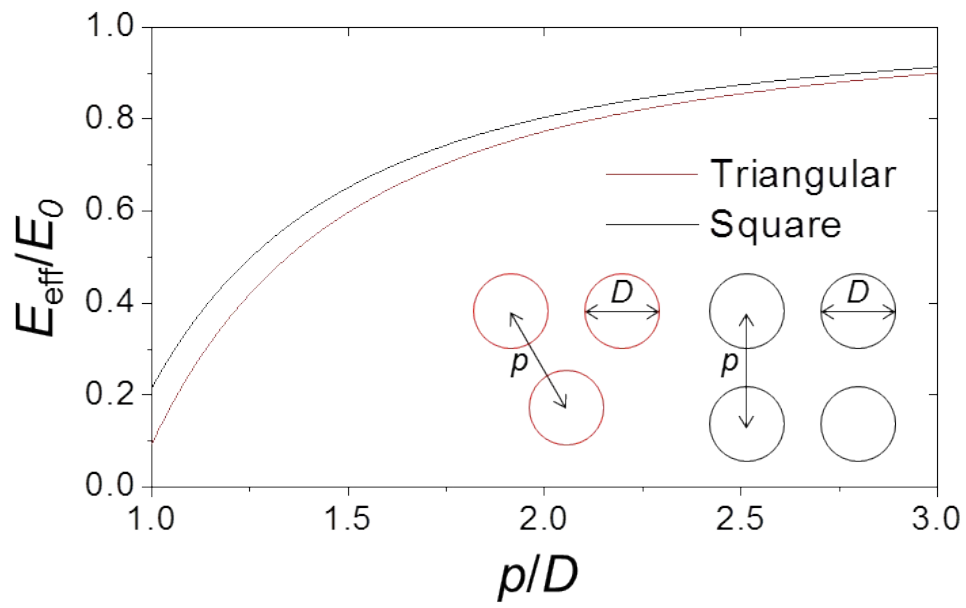
Figure S3. Effective Young's modulus of the membrane according to the pitch divided by the diameter of the aperture, *p/D*, with two aperture designs, triangular and square
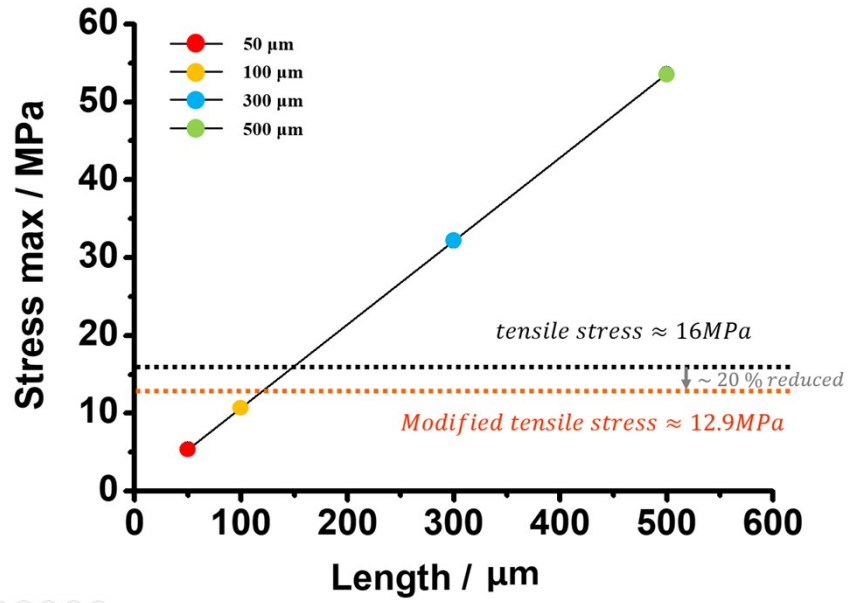
Figure S4. Comparison of modified maximum tensile stress and maximum applied stress to the membrane considering the nanoscale structure effect.
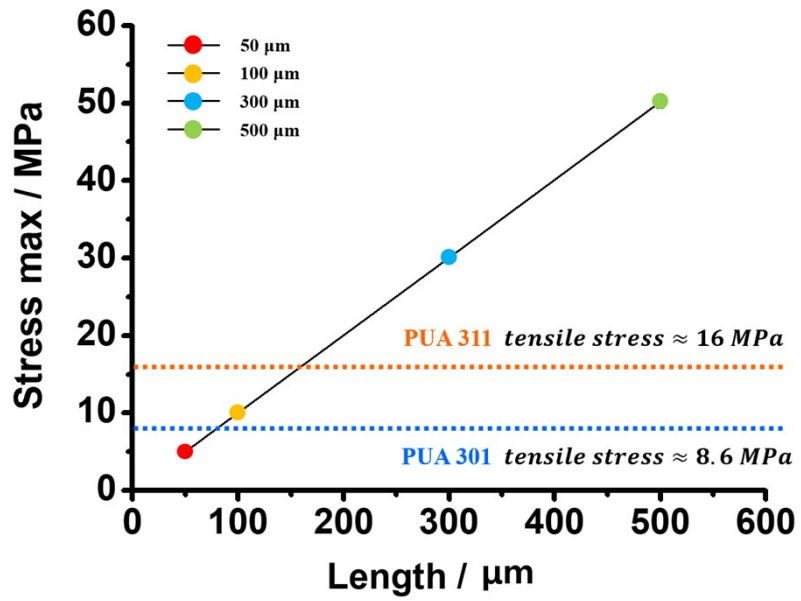
Figure S5. The stability criterion for the polymeric nano aperture membrane monolithically constructed on the micro aperture membrane with the material of PUA 301 and PUA 311. Maximum tensile stress – length relationship of four diameters micro PDMS mold.
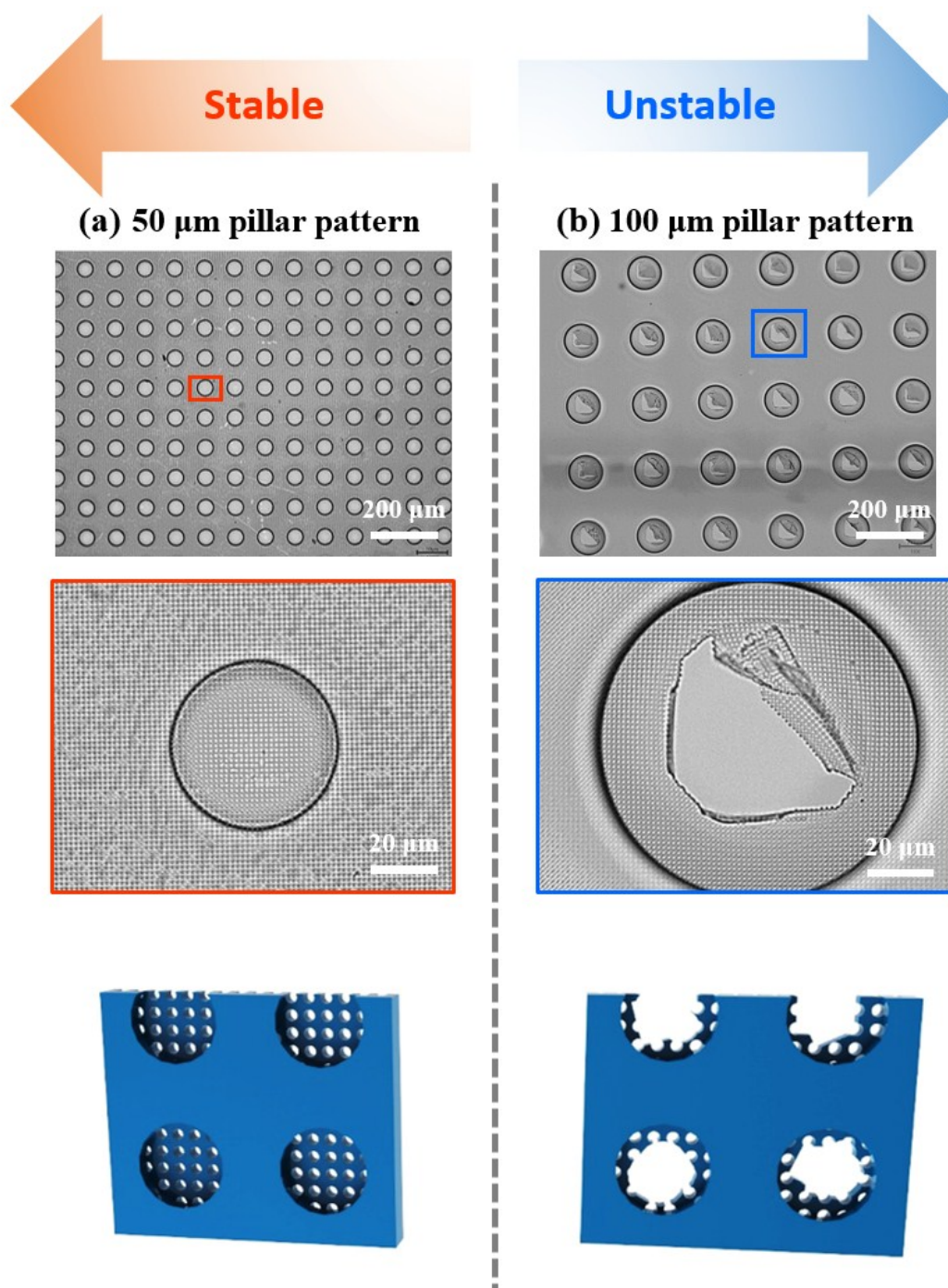
Figure S6. Optical microscopic images of polymeric membrane with the material of PUA 301, which consist of 800 nm hole layer and diverse micro hole sized supporting layers (50, 100 μm).

Table S1. Surface energy of the materials

Material	γ^d [mN/m]	γ^P [mN/m]	$\gamma \ (= \gamma^d + \gamma^P)$ [mN/m]	$W_{PDMS-PUA311}$ [mN/m]
PUA 301	10.5	8.8	19.3	
				32.2
PDMS	21.7	1.1	22.8	

Table S2. Maximum applied stress with the variation of diameter of supporting layer

Material	$\sigma_{max,\ 50\ \mu m}$ [N/mm]	$\sigma_{max,\ 100\ \mu m}$ [N/mm]	$\sigma_{max,\ 300\ \mu m}$ [N/mm]	$\sigma_{max,\ 500\ \mu m}$ [N/mm]
PUA 301	5.0	10.0	30.1	50.2
PUA 311	5.4	10.7	32.2	53.6