Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary Information

Shape-Controllabe Plano-convex Lenses with Enhanced Transmittance by Electrowetting on Nanotextured Dielectric

Xiangmeng Li, Xiangming Li, Jinyou Shao*, Hongmiao Tian, Chenbao Jiang, Yu Luo, Li Wang and Yucheng Ding

Micro &Nanotechnology Research Center, State Key Laboratory for Manufacturing Systems Engineering, Xi'an Jiaotong University, No.28 West Xianning Road, Xi'an, Shaanxi, China, 710049

**Corresponding author:* jyshao@mail.xjtu.edu.cn

Fig. S1- Fig. S8

Movie S1 and Movie S2

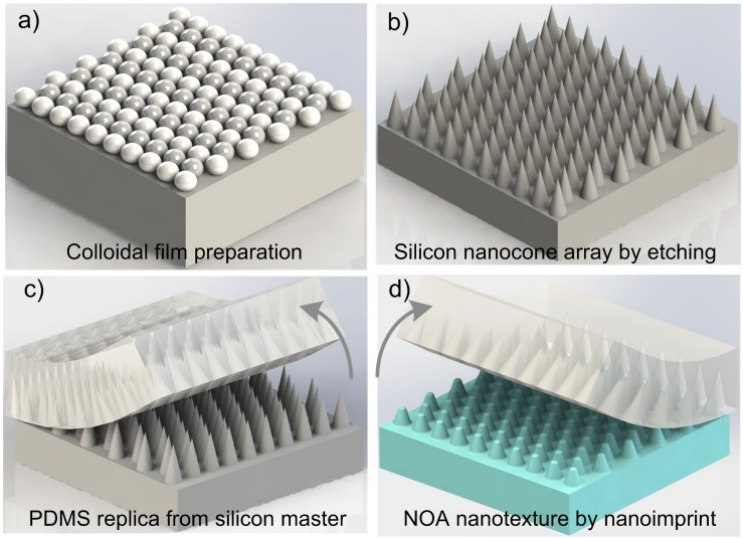

Fig. S1. Schematic diagram showing preparation of the colloidal film, silicon nanocone master, polydimethylsiloxane (PDMS) mold and Norland optical adhesive (NOA) nanotexture.

Experimental details:

(a) Preparation of colloidal film. The SiNPs were prepared by using Stöber's method[1], with average diameter of 360 nm. The SiNPs were thoroughly washed in ethanol for three times, and dried prior to re-dispersion in ethanol with 10 wt. %. The SiNPs solution was drop-wise supplied to a gap formed by a glass slide cover and silicon wafer, and then the glass slide was dragged by a programmable high-precision motor with an optimal speed of 125 µm s^{-1}. Once evaporating the ethanol solvent at room temperature of 25 °C and relative humidity of 35%, a monolayer of close-packed silica nanoparticles was formed on the silicon wafer[2].

(b) Preparation of silicon nanocone array. With the SiNPs monolayer as etching mask, dry etching process was performed with etching gases flow rates of SF_6 : C_4F_8 : O_2=12 sccm : 27 sccm : 10 sccm, RF power 300 W, ICP power 700 W, bias of 25 V, chamber pressure of 10 mTorr, and temperature of 25 °C. The appropriate etching duration was adjusted from 45 to 90 s to form desired silicon nanocone-array (SiNC) patterns.

(c) Preparation of PDMS mold. PDMS as degassed mixture of precursor and currant with mass ratio of 10:1 was poured on the SiNC patterns in a plastic dish, under vacuum chamber for 10 min, to remove the trapped air in the SiNC asperities and promote the penetration of PDMS mixture. After keeping still overnight, the PDMS dish was baked in 100 °C oven for 3 h, peeled off and cut into small pieces as nanoimprinting mold.

(d) Preparation of nanotextured dielectric layer. Fluorine-tin-oxide coated glass (FTO) was cut into suitable sizes and used as substrate. A drop of 3 µl UV-curable polymer (NOA, Norland products) was supplied onto the FTO substrate, covered with the PDMS mold with an area of about 3 cm^2. Then, the sandwiching set-up was irradiated with UV-ozone for 5 min. Upon cooling-down, the PDMS mold was released to form NOA nanotextured film of about 10 µm as a dielectric layer. Later, a thin layer of fluorocarbon (C_4F_8) was deposited by plasma enhanced chemical vapor deposition (PECVD), so as to separate the NOA droplet from the nanotextured dielectric[3].

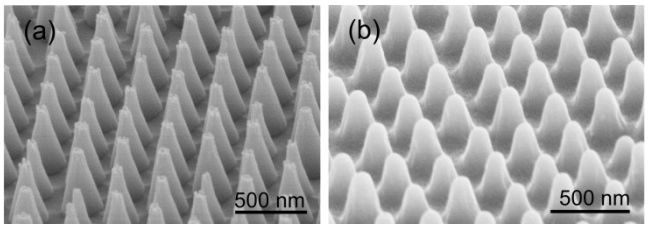

Fig. S2. SEM images of (a) Si nanocone pattern and (b) NOA nanotexture, characterized by field emission scanning electron microscope (Hitachi SU-8010, Japan).

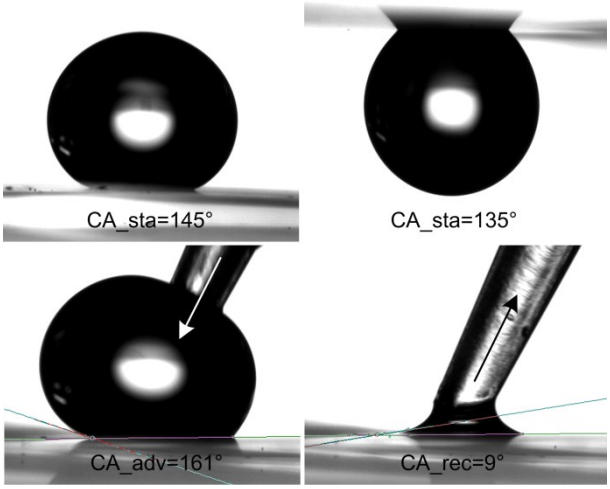

Fig. S3. Static and dynamic contact angle measurements of water droplets on the nanotextured NOA dielectric surface, performed on the Dataphysics platform (OCA20, GmbH).

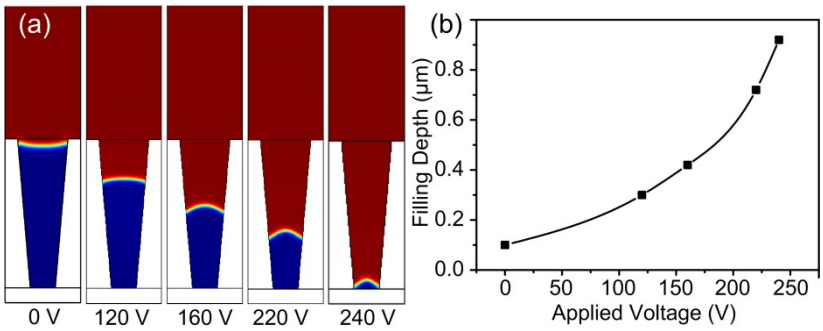

Fig. S4. Finite-element simulation of wetting state from Cassie-Baxter to Wenzel regime with increasing the applied voltage, using commercial software COMSOL Multiphysics (V5.0).[4]

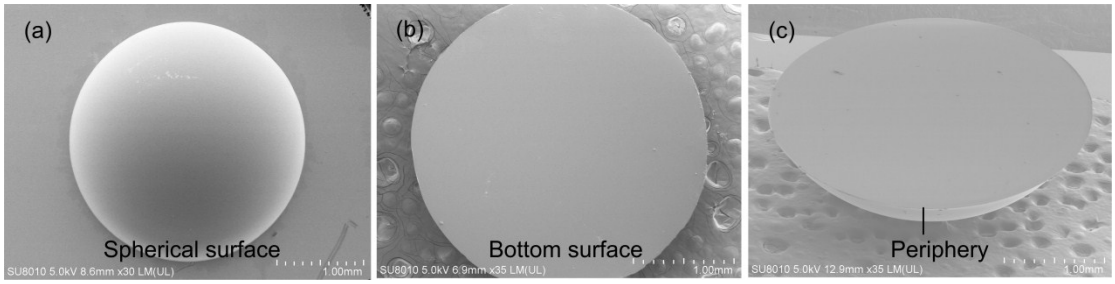

Fig. S5. SEM images of the resultant polymeric lens at (a) top view, (b) bottom view, and (c) side view respectively, indicating no apparent shrinkage or wrinkles after the UV irradiation.

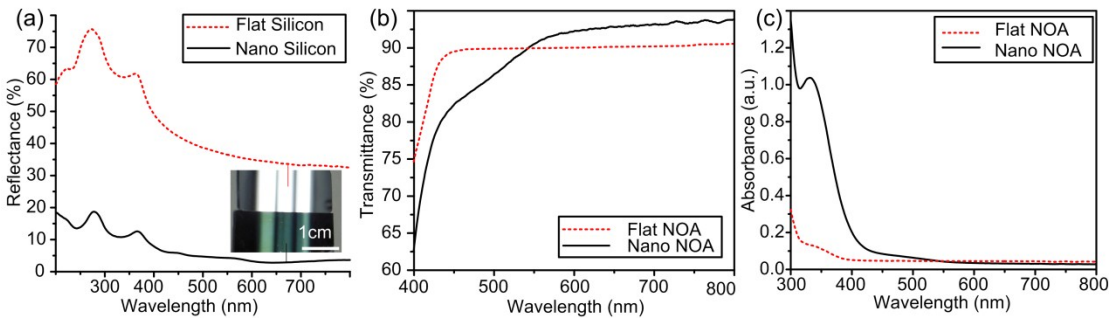

Fig. S6. Optical properties characterized by using UV-3600 (SHIMADZU, Japan). (a) Reflectance spectra of surfaces of silicon nanocone textured and flat silicon wafer. Inset shows the photos of the silicon samples under white light. (b) Transmittance and (c) absorbance spectra of the comparable flat and nanotextured NOA films.

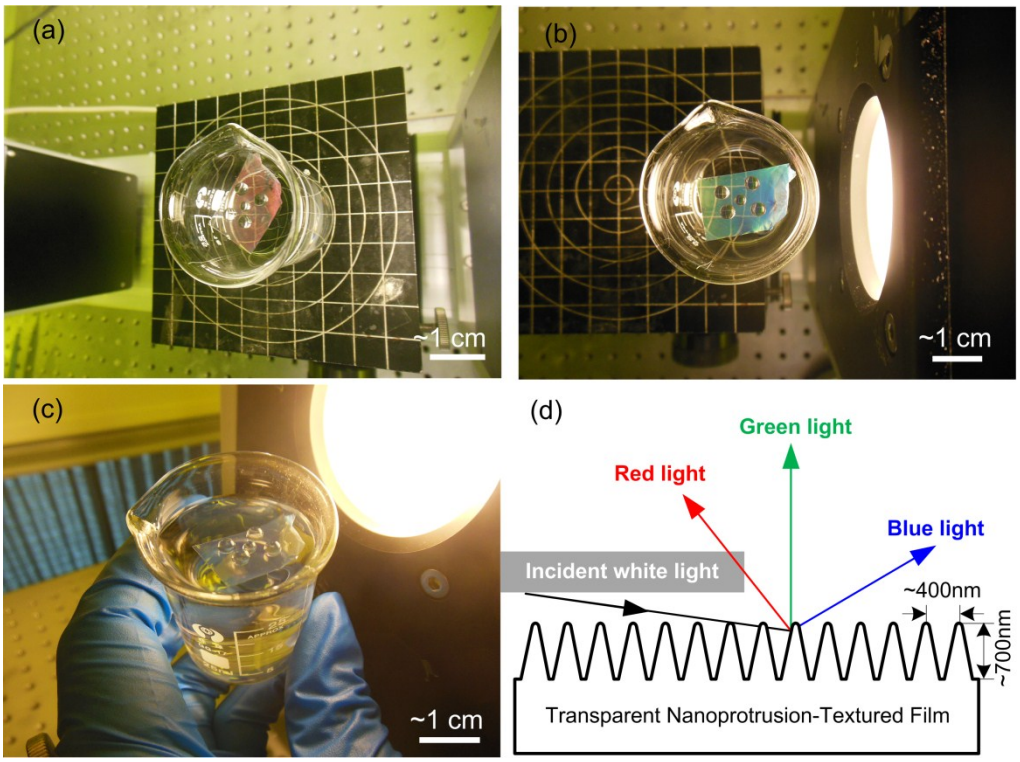

Fig. S7. (a)–(c) Demonstration of the angular dependent colors of free-standing nanotextured NOA film floating on water. (d) Schematic illustration shows the angular dependence colors. The free-standing NOA nanotextured film was fabricated by peeling off the polyethylene terephthalate (PET) substrate after nanoimprinting process with the same PDMS mold. These structure colors should be attributed to the Bragg diffraction on the periodic nanocone shape structures, which interact with the white light and reflect lights with varied wavelengths at different viewing angles.[5]

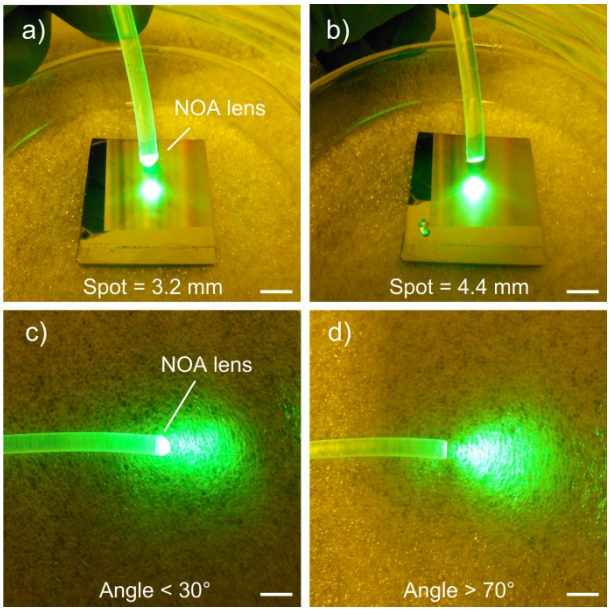

Fig. S8. Demonstration of optical fiber mounted with and without NOA lens, with better focusing of light and smaller angle for that equipped with NOA lens. Scale bars = 5 mm.

References

1. W. Stöber, A. Fink and E. Bohn, *J. Colloid Interface Sci.*, 1968, **26**, 62.
2. B. G. Prevo, D. M. Kuncicky and O. D. Velev, *Colloid Surface A*, 2007, **311**, 2.
3. X. M. Li, Y. C. Ding, J. Y. Shao, H. M. Tian and H. Z. Liu, *Adv. mater.,* 2012, **24**, OP165.
4. H. M. Tian, J. Y. Shao, Y. C. Ding, X. M. Li and H. Z. Liu, *Langmuir*, 2013, **29**, 4703.
5. W. H. Koo, S. M. Jeong, F. Araoka, K. Ishikawa, S. Nishimura, T. Toyooka and H. Takezoe, *Nat. Photonics*, 2010, **4**, 222.