Fabrication of transparent superoleophobic surfaces by multiple shrinking mask etching and layer-by-layer coating

Hyungryul J. Choi[1], Kyoo-Chul Park[1], Hyomin Lee[2], Jeong-Gil Kim[1], Robert E. Cohen[2], Gareth H. McKinley[1], George Barbastathis[1,3]

Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, United States,
[2]Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, United States,
[3]Singapore-MIT Alliance for Research and Technology (SMART) Centre, Singapore

A major challenge in surface engineering is the creation of transparent surfaces that repel low surface tension liquids, such as oils. In recent years, transparent superoleophobic surfaces have been developed by using deposition of candle soot with a thin silicon dioxide layer, followed by subsequent thermal heat treatment and application of suitable chemical coatings [1] or through polymer micromolding methods [2]. However, it is difficult to maintain optical transparency in the visible wavelength range and resistance to wetting by low surface tension liquids with the same surface texture due to scattering of light and wetting failure of the super-oleophobic state by external perturbations such as vibrations or high-velocity droplet impact. Fractal-like soot structures deposited on glass surfaces and micro-molded structures can induce optical scattering that results in haze and low transmissivity. On the other hand, superoleophobicity on micromolded re-entrant structures is limited to quite mild droplet impact conditions due to the relatively large length scale of the structure [3].

Here, we propose a re-entrant subwavelength nanocone surface structure for enhanced transparency and superoloephobicity. The re-entrant texture is created using a square array of silica nanocones coated uniformly with silica nanoparticles. We combine top-down and bottom-up fabrication processes: interference lithography and multiple shrinking mask etching to pattern the primary nanocone structure [4]; and layer-by-layer (LbL) assembly [5] to add the secondary structure that consists of a nanoparticle coating that gives rise to re-entrant textures (see Fig. 1&2). The resulting encrusted structures are calcinated and finally coated with a low-energy chemical coating. Using the described fabrication method, we strive to develop robust superoleophobic and super-transmissive silica surfaces which can be used for real-world applications such as transparent fingerprint-resistant surfaces.

REFERENCES

[1] X. Deng, *et al*., *Science*, 335, pp. 67–70, (2012).

[2] S.M. Kang, *et al*., *Soft Matter*, 8, pp. 8563–8568, (2012).

[3] A. Tuteja, *et al.*, *PNAS,* 105, pp. 18200-18205, (2008).

[4] K.-C. Park, *et al*., *ACS Nano*, 6, pp. 3789–3799, (2012).

[5] J. Bravo, *et al*., *Langmuir*, 23, pp.7293–7298, (2007).

*hr_choi@mit.edu

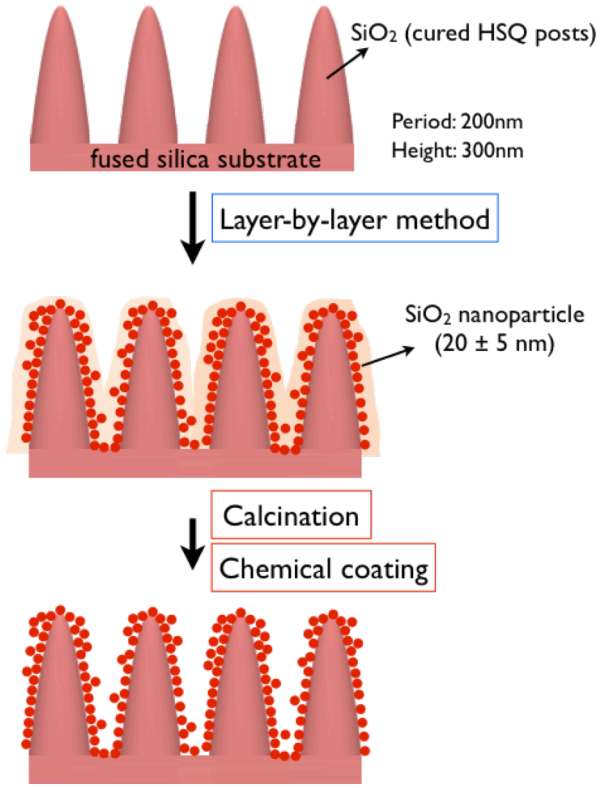

Figure 1. Schematic of the process for fabricating transparent superoleophobic surfaces

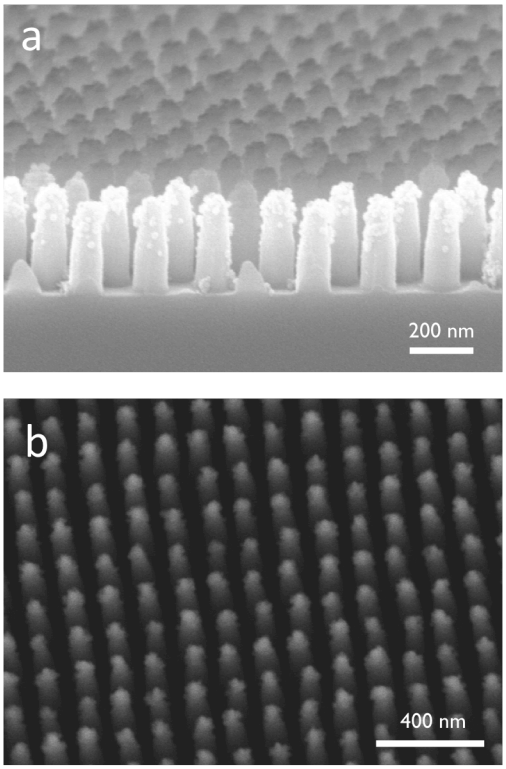

Figure 2. SEM images of fabricated subwavelength nanocone structures encrusted with LbL-deposited nanoparticles. a) oblique view. b) top view.