Tailoring Anisotropic Wetting Properties on One-Dimensional Nanopatterned Surfaces

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Wetting phenomena on structured solid surfaces are of both fundamental and technological interest. Engineered surfaces exhibiting superhydrophobicity have been reported. Anisotropic wetting behavior has been observed on one-dimensional (1D) patterned surfaces achieved either through chemical patterning or surface roughness. [1]-[3] Several approaches to altering the wetting-to-dewetting transition have been explored including: chemical mediation, laser irradiation and the application of an electric field. Here, we report the observation of strongly anisotropic wetting behavior on 1D patterned surfaces and simple approaches to tailoring the anisotropic wetting.

Nanopatterned surfaces were fabricated by interferometric lithography. We observed strongly anisotropic wetting behavior on 1D nanopatterned surfaces using both positive (sample A in Table I) and negative photoresist (sample B in Table I). The contact angle θ_x (perpendicular to the photoresist lines) is around 120^o while the contact angle θ_y (parallel to the photoresist lines) is around 50^o. Previously, we had demonstrated that silica nanoparticles modified the anisotropic wetting properties on as-prepared samples.[3] Here, we employed a standard semiconductor process, plasma etching, to adjust the anisotropic wetting properties. First, we used a short CHF_3 plasma treatment to tune the surface to ultrahydrophobic with a lowered anisotropy on 1D patterned surfaces. We also applied CF_4 plasma treatment as well and the results shows no apparent different from CHF_3 treatment. After CHF_3 or CF_4 treatment, the photoresist pattern profile is almost unchanged (Fig 1.A and B). Second, we used a short O_2 plasma treatment to adjust the surface to ultrahydrophilic and less anisotropic on 1D patterned surfaces. With O_2 plasma treatment, the dimensions in photoresist patterns decrease slightly due to plasma etching of the polymers (Fig 1. C and D). Furthermore, the anisotropic wetting properties on 1D patterned samples could be recovered with spin-coating a thin layer of photoresist at high spin-speed on the above treated samples. Finally, we also demonstrated that the wetting properties of 1D patterned Si surfaces also could be tuned with plasma treatment. The ability to tailor anisotropic wetting on 1D patterned surfaces will find many applications in microfluidic devices, microreactors and self-cleaning surfaces.

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[1] Gleiche, M.; Chi, L. F.; Fuchs, H. *Nature* **2000**, *403*, 173.
[2] Chung, J. Y.; Youngblood, J. P.; Stafford, C. M. *Soft Matter* **2007**, *3*, 2608.
[3] Xia, D.; Brueck, S. R. J. *Nano Letters,* **2008**, 8, 2819.

Table 1. Contact angle data on 1D photoresist patterned samples.

Sample	**Original, θ_x**	**Original, θ_y**	**CHF_3, θ_x**	**CHF_3, θ_y**	**O_2, θ_x**	**O_2, θ_y**
A	126	52	127	108	0	0
B	110	58	140	108	<5	0

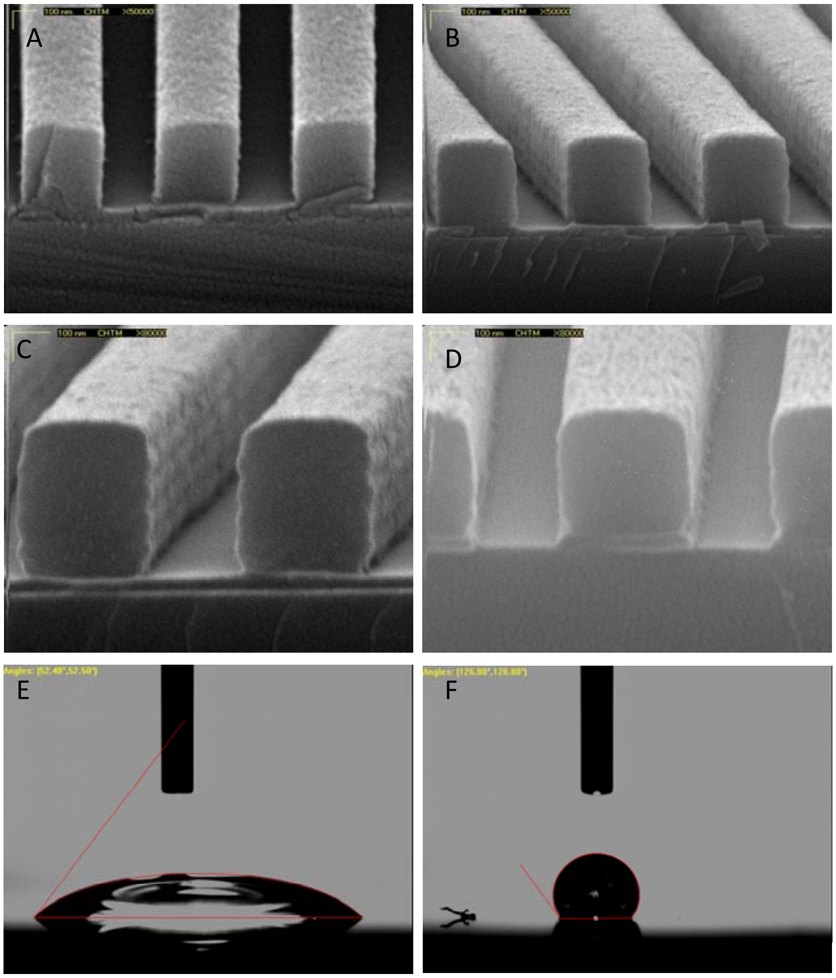

Figure 1. SEM images and contact angle images for 1D nanopatterned samples with 800-nm pitch using negative photoresist: (A)-(B) before and after CHF_3 treatment; (C)-(D) before and after O_2 treatment; (E)-(F) contact angle θ_y and θ_x for untreated sample.