Anisotropic Wetting Behavior of One-Dimensional Patterns and Application to Fluidic Devices

Deying Xia and S. R. J . Brueck
Center for High Technology Materials, University of New Mexico,
1313 Goddard SE, Albuquerque, New Mexico 87106.
E-mail: brueck@chtm.unm.edu, dyxia@chtm.unm.edu

Micro- and nano-patterned surfaces are being actively studied for practical applications in electronics, optics and biology. A number of investigations have focused on the wetting behavior of water on micro-patterned surfaces. To date, most work has focused on isotropic wetting behavior on homogeneously patterned 2D surfaces with pattern feature sizes of micrometer scale or larger. It remains to investigate anisotropic wetting behavior on one-dimensional micro- and nano-patterned surfaces that will find application in novel micro- and nano-fluidic devices for drug release controlling, biomimetic structures, biological detection and separation.

In this work, we fabricated 1D photoresist (hydrophobic) patterns on Si (hydrophobic) and SiO_2 (hydrophilic) substrates using interferometric lithography. The static contact angles (CA) were measured on these patterned samples and on the homogeneous films. Strongly anisotropic wetting was hydrophobic characteristic on 1D PR patterns (Fig. 1). We could manipulate anisotropically hydrophobic surface to anisotropically hydrophilic surfaces using silica nanoparticles. The dependence of the anisotropic wetting on the pattern periodicity, exposed surface, and droplet distortion (ratio of major axis to minor axis of droplet) are discussed (Table 1). The distortion of the droplet was as high as 4 for 1D PR patterns and reached as high as 8 after silica nanoparticle modification. The elongated droplets move easily along the PR direction while being almost pinned in the orthogonal direction, even at tilts approaching the vertical direction.

This anisotropic wetting behavior on 1D patterns offers interesting possibilities for the application to novel micro- and nano-fluidic devices, surface micro- and nano-channel devices, lab-on-chip devices and surfaces for water harvesting and drug release control. This simple and effective approach avoids complicated chemical procedures to introduce functional groups.

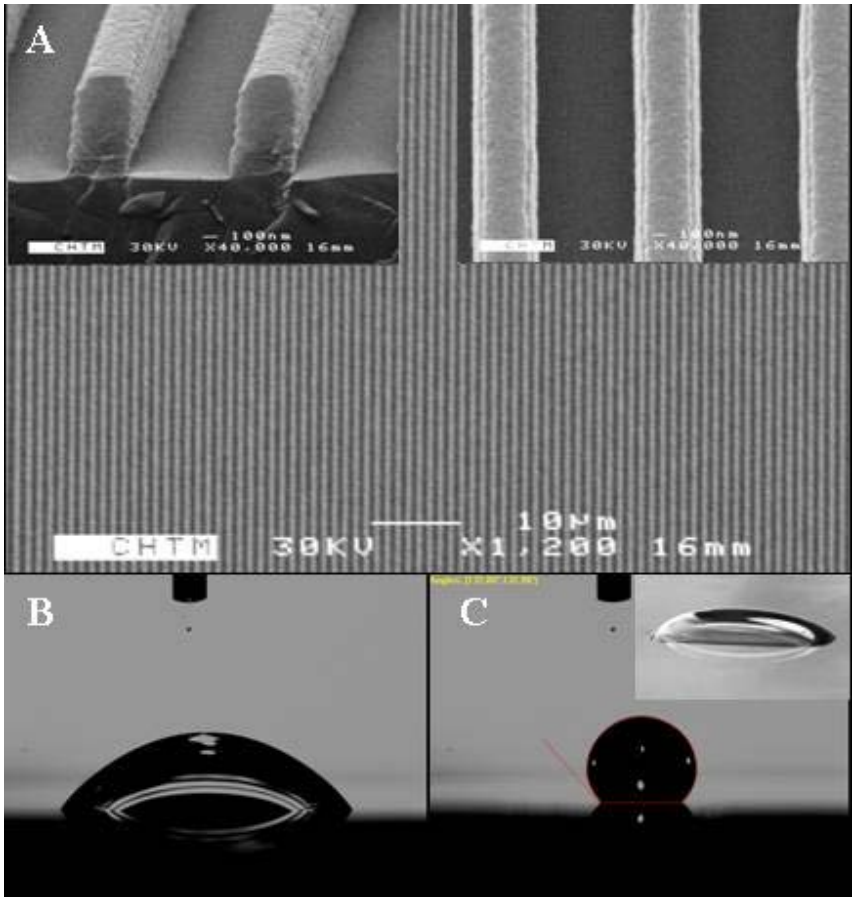

Fig. 1. Anisotropic wetting of 1D patterns: (A) SEM image of 1D patterns with 1500nm period (inset: cross-view and magnified top-view); (B) 1.5 μL water drop parallel direction of line; (C) 1.5 μL water drop orthogonal direction of line (inset: photography of water droplet profile (30μL) on sample surface)

Table I. Static contact angles and droplet distortion for 1D patterns with negative photoresist NR7-500P

Sample	CA, parallel direction of line	CA, orthogonal direction of line	droplet distortion
1D, 1500-nm period	50.8	130	3.5-4
1D, 1500-nm period with silica particles	7.8	38	8-9
1D, 420-nm period	41.4	102	