

**Pixelated chemically amplified resists: investigation of material structure on the spatial distribution of photoacid and line edge roughness**

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Chemically amplified photoresists have been widely used in the photolithographic process to fabricate advanced integrated circuits and other devices. Unfortunately several factors such as heterogeneity of the resist films and photo acid diffusion during the post-exposure bake (PEB) are the critical impedance to high resolution patterning with low line edge roughness (LER). Applying pre-organized resists with uniform structure where the PAGs could be located or isolated in the defined regions might be one of the solutions to address these issues. Here we synthesized pixelated photoresists to investigate the relationship between the structure of the photoresists and the spatial distribution and diffusion of photoacid and LER. The pixelated photoresist was created by self-assembly of diblock copolymers and designed to isolate photo acid generator (PAG) into only one block of block copolymers that contains an acid-labile functionality. The other block has low photoacid solubility to reduce acid diffusion. Asymmetric poly(styrene)-block-poly(*t*-butylacrylate) (PS-*b*-P*t*BA) diblock copolymer forms PS cylinders within the P*t*BA matrix (Figure 1(a)). The morphology of this block copolymer however transformed into spheres by adding 5% of PAG (Figure 1(b)). The PAG molecules are sequestered to the P*t*BA block and the expanded volume of the matrix block induces a phase transition from cylinders to spheres. Meanwhile, the PS spheres (pixels) are impermeable to PAG, such that the chemistry of chemical amplification occurs only in matrix block. When the film was exposed to UV or X-ray radiation through a mask, baked and developed, entire polymer chains in the exposed regions dissolved in aqueous base solution (Figure 2). Interestingly, we could observe the characteristic granular structure in the edge of the patterns, and the size of the granules (ca. 35 nm) was quite similar to the dimension of non-polar PS domains in the resist film (diameter: 23 nm, center to center distance: 40 nm). This result shows that the LER in the pixelated resists can be directly correlated to the domain (pixel) size of the copolymers and it may be controlled in nanometers level by minimizing the pixel size. We are now investigating the effect of pixelated structure of photoresist on the acid-diffusion.

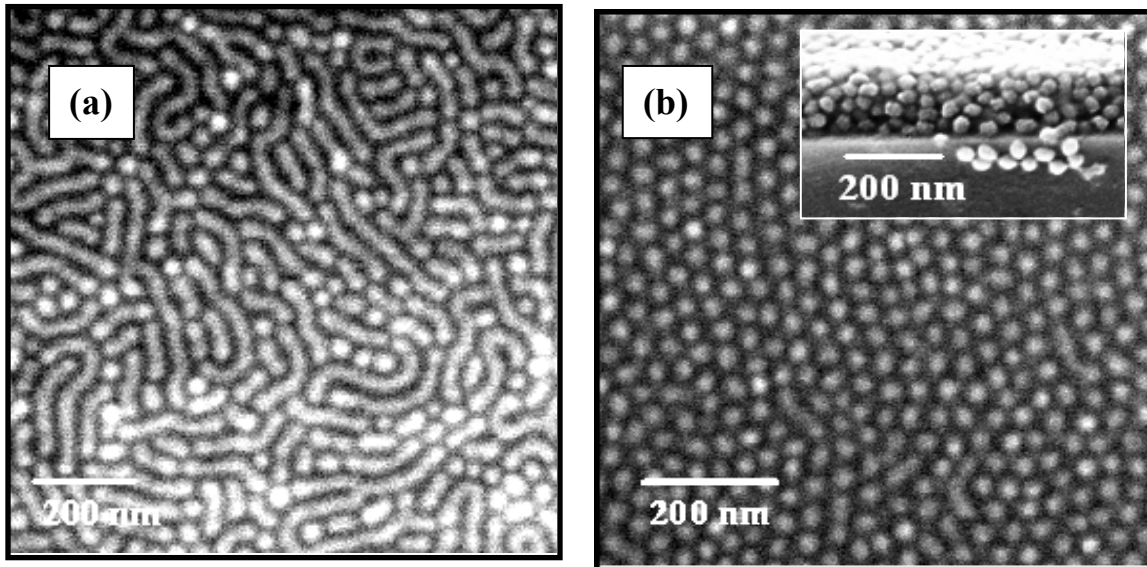


Figure 1. Plan-view SEM images of PS-*b*-PtBA diblock copolymer before (a) and after (b) adding 5% PAG. (a) PS cylinders within PtBA matrix. (b) PS spheres within PtBA matrix (PAG molecules locate in the PtBA block). (inset in (b): cross-sectional SEM image)

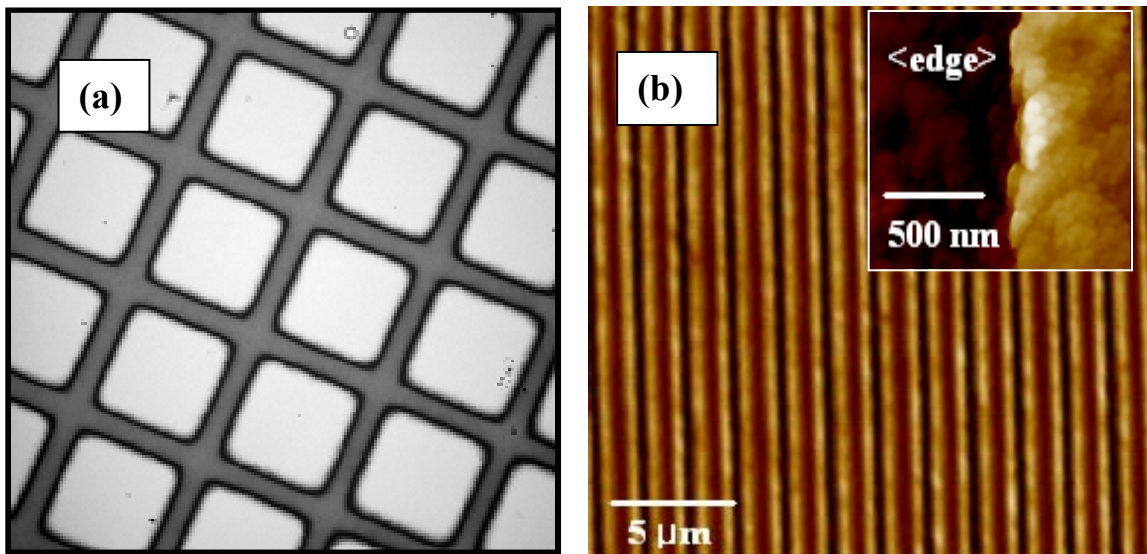


Figure 2. (a) OM image of PS-*b*-PtBA film patterned by UV (255 nm) (25 μm bar width, 105 μm x 105 μm squares) (b) AFM image of PS-*b*-PtBA film patterned by X-ray (Inset: edge structure)