



# Directed Assembly of ABA Triblock copolymers for BPM fabrication

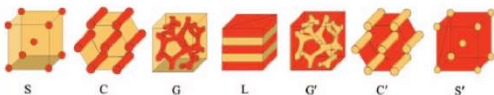
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**Abstract:** We report the use of solvent annealing method on the directed self-assembly of symmetric ABA triblock copolymer to form perpendicularly oriented lamellae on chemical contrast patterns for the fabrication of bit patterned media (BPM). We showed that triblock copolymers provide great processing window in terms of pitch commensurability. Using block-selective infiltration, the alumina composite with high etch resistance was specifically incorporated into the polar and hydrophilic P2VP domains; thereby the surface pattern was successfully transferred into underlying Si substrates by fluorinate-containing plasma etching. The assembled lamellae formed one of the orthogonal line patterns for the intersecting imprint master templates.

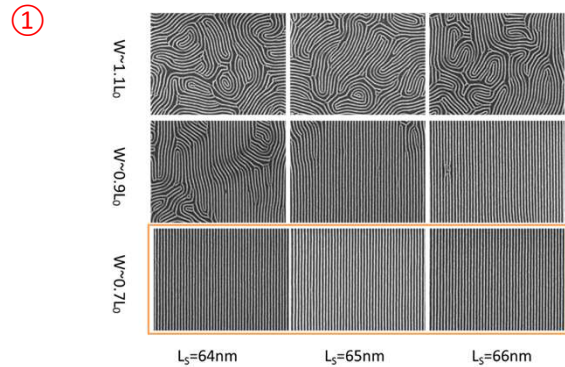
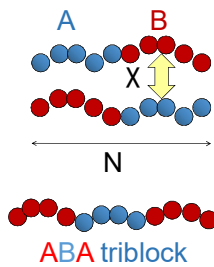
## Introduction



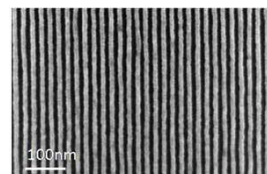
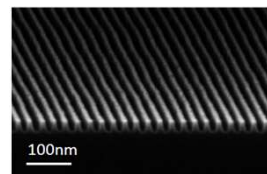
X: Flory-Huggins parameter  
N: polymerization degree  
f: volume fraction of A block

Block copolymers made of two distinctive segments can form a variety of different morphologies based on microphase separation. Our focus is on using DSA to create line space pattern and extend to BPM fabrication. (Reference 1, 2)

As reported before, the rectangular bits in BPM can be defined by cutting the striped patterns formed by lamellae-forming block copolymers. Nanoimprint templates for BPM with rectangular islands can be fabricated by the orthogonal intersection of two separate submaster templates: one with an array of circumferential stripes and a second one with an array of radial "spokes". (Reference 3)



① Master on Si

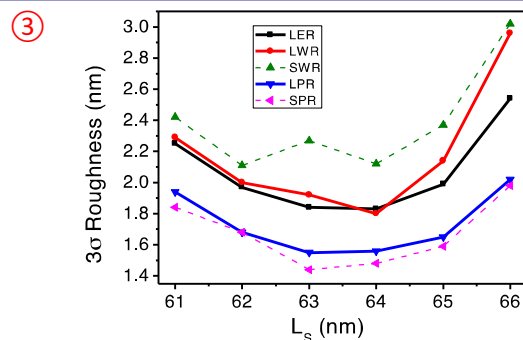


Replica on quartz

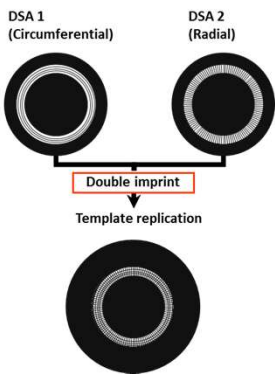
① 3X DSA of 21nm triblock on chemical pattern prepared by rotary e-beam lithography. The DSA of this triblock copolymer on different commensurable pitches ( $\pm 3\%$ ) enables defect-free patterning in large area (with skew) on the disk drive.

② A nanoimprint master template on a 6-inch Si wafer. Circumferential line/space patterns for the chemical contrast patterns were generated from a rotary e-beam along a  $\sim 2$  mm band centered at a 13 mm radius. The 6-inch Si master template was used to imprint a replica pattern on a quartz wafer.

③ Line roughness of the  $\text{Al}_2\text{O}_3$  line/space patterns was measured from square SEM images 1.8 mm long having a pixel size of 0.9 nm using image analysis. Results are displayed in the form of  $3\sigma$  values for line edge, width and placement roughness (placement roughness refers to the roughness of the centroid line).

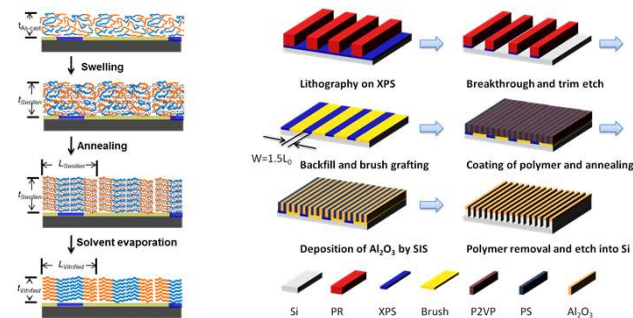


③



	Circ (nm)	27 (PS-b-PMMA) Td/in <sup>2</sup> BAR		22 (PS-b-PMMA) Td/in <sup>2</sup> BAR		21 (VSV) Td/in <sup>2</sup> BAR	
Rad (nm)							
22 (PS-b-PMMA)	1.1	1.2	1.3	1.0			
21 (VSV)	1.1	1.3	1.4	1.0	1.5	1.0	
20.5 (SADP)	1.2	1.3	1.4	1.1	1.5	1.0	
16 (VSV)	1.5	1.7	1.8	1.4	1.9	1.3	
14.5 (SADP)	1.7	1.9	2.0	1.5	2.1	1.4	

Method and geometry of circumferential and radial lines aiming at BPM over 1Tb/in<sup>2</sup>.  
SADP: self-aligned double patterning  
VSV: P2VP-b-PS-b-P2VP triblock copolymer



Combining the DSA, SIS, and nanoimprinting, a new process flow has been demonstrated in this report. The new high  $\chi$  block copolymer allowed us to access smaller pitch size below the limit imposed by PS-b-PMMA, and it can be extended down to 14nm in theory.

## Conclusions

In summary, we have demonstrated a strategy of DSA of lamellar phase P2VP-b-PS-b-P2VP triblocks with pattern transfer that opens a path to extend block copolymer lithography below 22 nm pitch. We also demonstrated the fabrication of a nanoimprint template by performing an infiltration synthesis of  $\text{AlOx}$  inside the P2VP domains and subsequent pattern transfer into a Si wafer. The quality of the template was verified by its low roughness values and a successful imprint of a replica pattern. Recently we successfully pushed the resolution down to 8nm in half pitch with the same material and processing (Reference 4).

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## References

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