

Holography of Making 1D-Nano-Trench-Lines and 2D-Nano-Posts

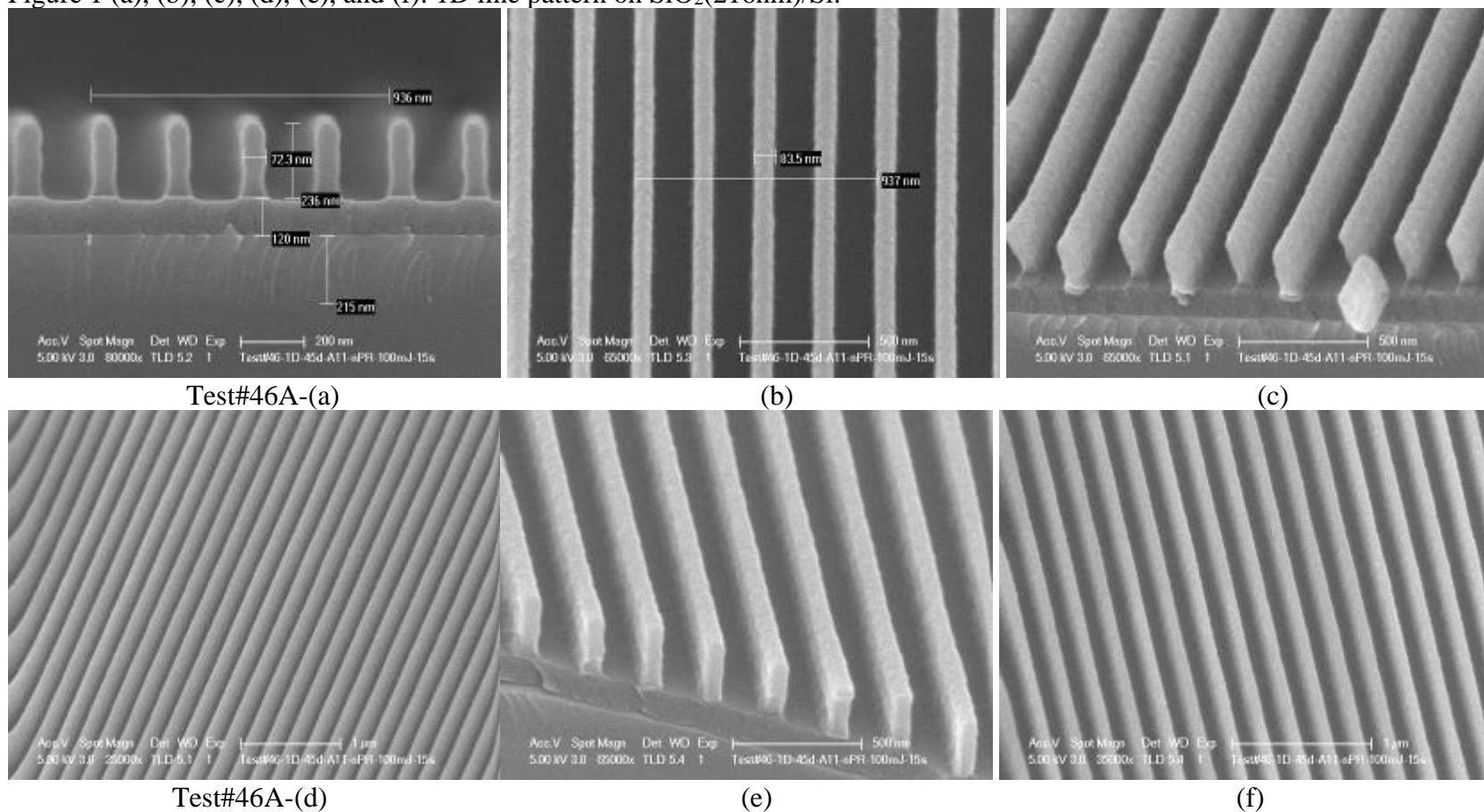
Laser: He-Cd Gas Laser ($\lambda=325\text{nm}$).

Pitch Distance d: 200~300nm (θ : 54~33°).

A) Process Details of the holographic 1D-line pattern (210nm thick SiO₂ deposited on Si; the angle between sample surface and incoming laser incident light $\theta=45^\circ$)

- 1 Cleaning sample(s) with acetone (2min.) and methanol (1min.) in ultrasonic bath, then, DI-water rinse and N₂ blow-dry
- 2 Dehydration at 115C for 10min. (20 min. for GaN/Sapphire substrate, with the hot plate lid closed).
- 3 Spin-on XHRiC-11 (ARC) at 2000 rpm for 40sec (using 2000 rpm if the Holography is very sensitive to 3~4% residue reflectance for some underneath EPI layer(s)/substrate).
- 4 Bake at 175C for 1min. (2 min. for GaN/Sapphire substrate, with the sample covered by an aluminum dish).
- 5 Waiting for 2min.
- 6 Spin-on THMR-IP3600HP-D resist at 5000rpm for 30sec
- 7 Bake at 90C for 90sec (3 min. for GaN/Sapphire substrate, with the hot plate lid closed).
- 8 Exposing the resist with an energy dose of 100mJ (if using 54°, with a pinch~200nm, expose dose increases to 120mJ)
- 9 Post-exposure-bake (PEB) at 115C for 120sec (3 min. for GaN/Sapphire substrate, with the hot plate lid closed).
- 10 Developing the resist in AZ300MIF developer for 15 sec, then, DI-water rinse (small DI water flow) and N₂ blow-dry (small gun pressure, less than 20psi)
- 11 O₂ plasma descum with 300mT/100W for 20sce

Figure 1 (a), (b), (c), (d), (e), and (f): 1D line pattern on SiO₂(216nm)/Si.

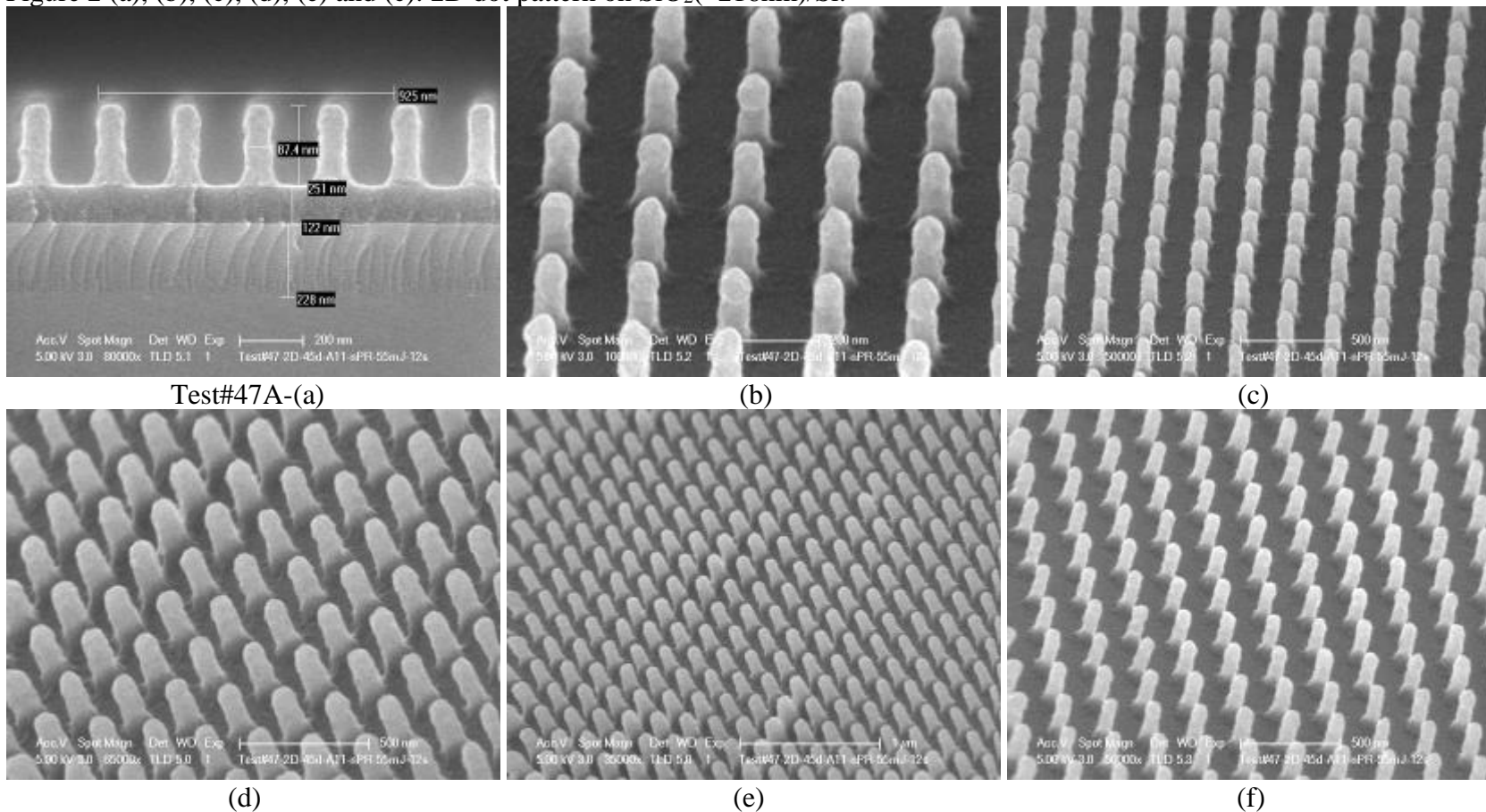


Note: the thickness of XHRiC-11 is ~120nm with the spin-on speed of 3000rpm and the pitch of the line period is ~234nm.

B) Process Details of the holographic 2D-dot pattern (~216nm thick SiO₂ deposited on Si; $\theta=45^\circ$)

- 1 Cleaning sample(s) with acetone (2min.) and methanol (1min.) in ultrasonic bath, then, DI-water rinse and N₂ blow-dry
- 2 Dehydration at 115C for 10min.
- 3 Spin-on XHRiC-11 (ARC) at 2000 rpm for 40sec
- 4 Bake at 175C for 60sec
- 5 Waiting for 2min.
- 6 Spin-on THMR-IP3600HP-D resist at 5000rpm for 30sec
- 7 Bake at 90C for 90sec
- 8 Exposing the resist with an energy dose of 55mJ (twice for 2D-dot pattern with the sample orientation rotated 90°)
- 9 Post-exposure-bake (PEB) at 115C for 120sec (then, waiting for 2 min.)
- 10 Developing the resist in AZ300MIF developer for 12 sec, then, DI-water rinse (small DI water flow) and N₂ blow-dry (small gun pressure, less than 20psi)
- 11 O₂ plasma descum with 300mT/100W for 20s

Figure 2 (a), (b), (c), (d), (e) and (f): 2D dot pattern on SiO₂(~216nm)/Si.



Attachment#1: Etch ARC-11 layer to transfer the PR pattern into ARC-11 layer using RIE#5

1) RIE#5 chamber O₂ plasma clean: 8mT, O₂ flow-rate=20 sccm, power=200 W, and clean time=10 minutes

2) Etch ARC-11: 5mT, O₂ flow-rate=20 sccm, power=150 W, and etch time=80 seconds.

For the etch profiles, see the file, Holography Process Variations-Set-up Angle-Etching into Si with a different line-width, in Wiki under the Category of Lithography Recipes/Holography Recipes.

Attachment#2: Etch SiO₂ layer to transfer the ARC-11 pattern into SiO₂ layer using ICP#2

Etch SiO₂: 0.5 Pa, 50/900W, CF₄/CHF₃ flow-rate=30/10 sccm, etch rate=160 nm/min. and selectivity (SiO₂/PR) \approx 1.2

For the other etch recipes with different side-wall angles, please refer to the file, Etch SiO₂ Nano-structure-changing side-wall Angle-Etching into Si with a different line-width, in Wiki under the Category of Lithography Recipes/Holography Recipes.