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

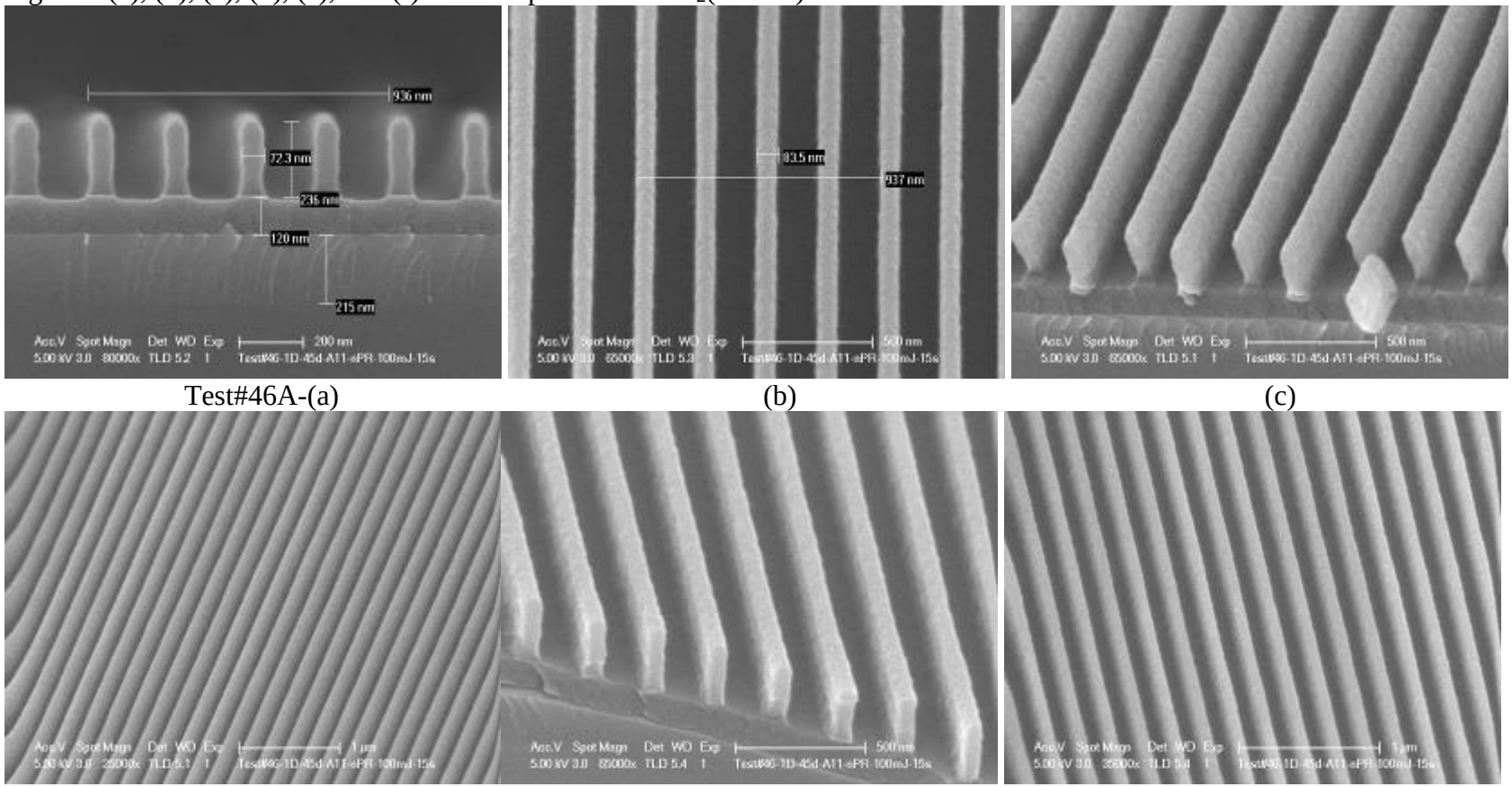
Laser: He-Cd Gas Laser (λ=325nm).

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

A)Process Details of the holographic 1D-line pattern (210nm thick SiO_2 deposited on Si; the angle between sample surface and incoming laser incident light θ=45^o)

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^o, 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 SiO_2(216nm)/Si.



Test#46A-(a) (b) (c)

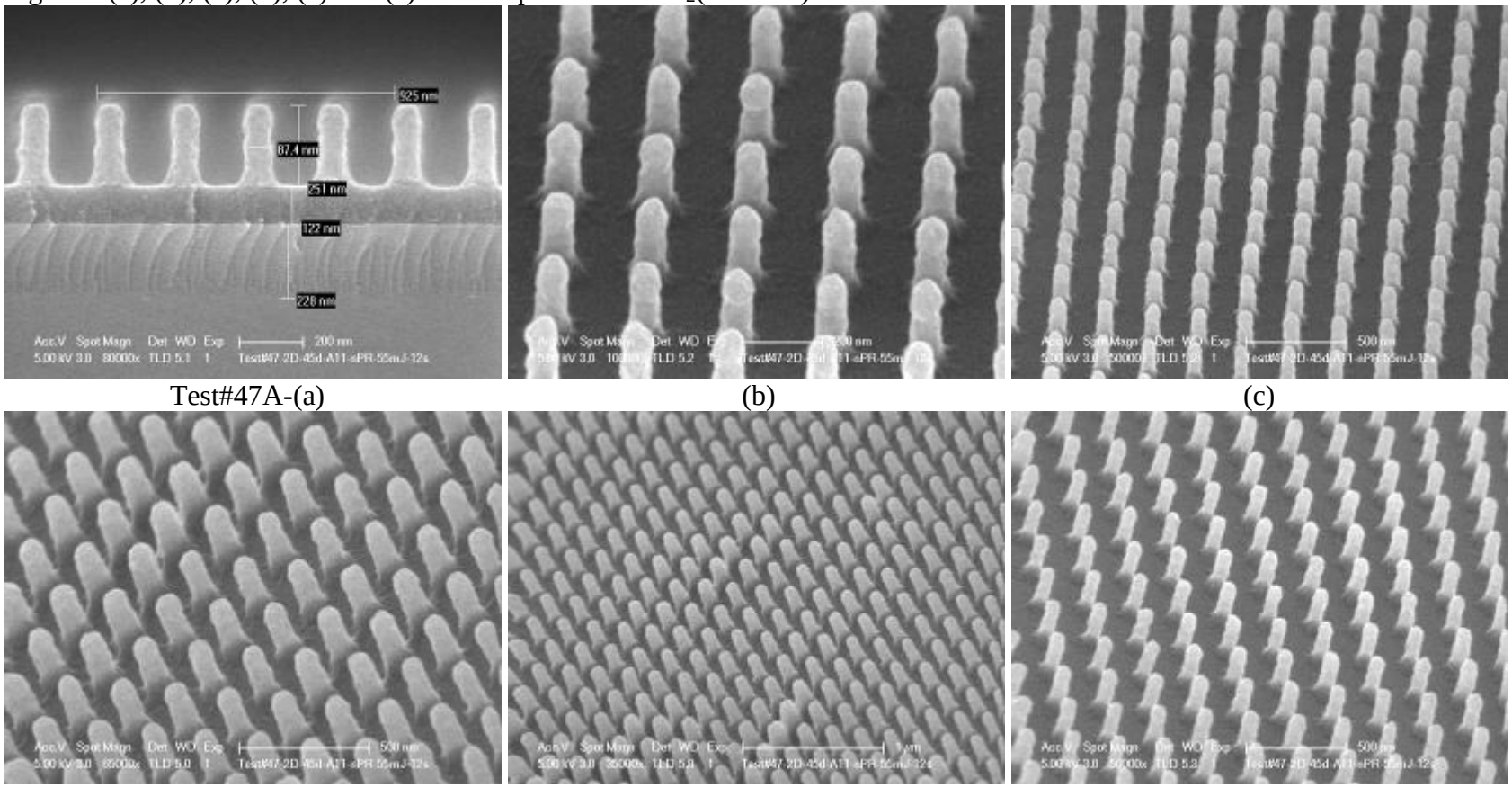
Test#46A-(d) (e) (f)

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 SiO_2 deposited on Si; $\theta=45^o$)

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^o)
9 Post-exposure-bake (PEB) at115C 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 20sce

Figure 2 (a), (b), (c), (d), (e) and (c): 2D dot pattern on SiO_2(~216nm)/Si.



Test#47A-(a) (b) (c)

(d) (e) (f)

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: recipe name: cao_2o2, 8mT, O2 flow-rate=20 sccm, power=200 W, and clean time=10 minutes
2) Etch ARC-11: recipe name: cao_2o3, 5mT, O2 flow-rate=20 sccm, power=150 W, and etch time=150 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) ≈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.