etching PECVD oxide using PT ICP with ZEP520 mask

Devin Brown

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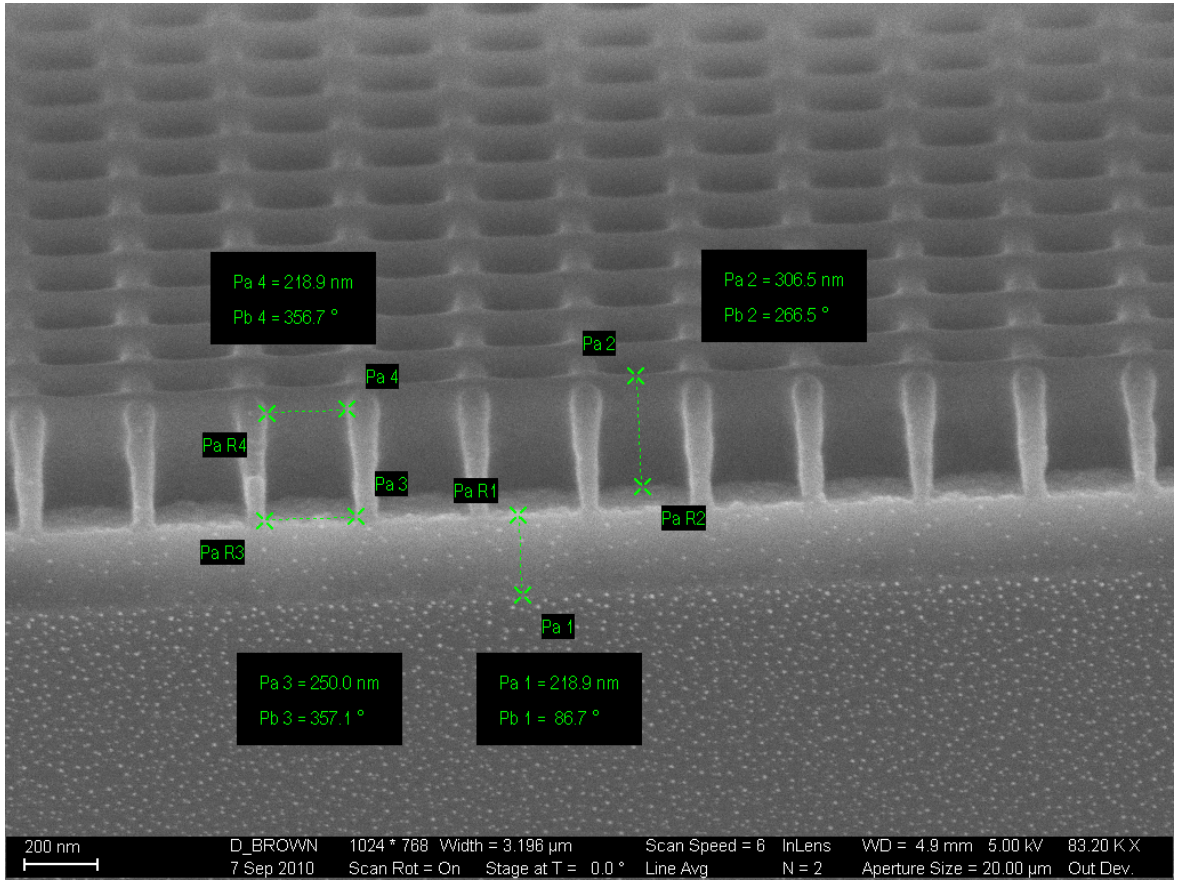
Process Flow

- 4” diam. 100 orientation silicon substrate
- PECVD oxide deposition
    - tool = Unaxis PECVD
    - recipe = std_ox
        - 900 mTorr, SiH4 400 sccm, N20 900 sccm, 25W @ 13.56MHz, T=250C
    - dep rate =rate ~578 A/min, t= 4min 20sec
    - thickness = 247 nm, Nanospec reflectometer
- ZEP520A coat
    - 3000 RPM, 1500 RPM/s, 60 sec
    - 180 C, hot plate bake, 2min
    - ~340 nm thickness, Dektak profilometer
    - break 4” wafer into pieces for further processing
- EBL exposure
    - tool = JBX-9300FS
    - 100kV, 15nA, aperture = 7
    - dose range = 220 – 260 uC/cm2 (for 200 nm squares on 300 nm pitch)
- Develop
    - 2 min immersion in amyl acetate
    - 30 sec immersion rinse in IPA
- Oxide Etch
    - pieces mounted on Si carrier wafer
    - tool = PT ICP
    - recipe = C4F8_OX
        - 5 mTorr, 28 sccm CO2, 15 sccm C4F8, 5 sccm Ar, 40 W RIE, 800 W ICP
    - etch time = 84 sec
    - observed DC bias = 162 V

Post develop, prior to etch

200 nm squares on 300 nm pitch

15 nA current, dose = 240 uC/cm2



ZEP520

PECVD oxide

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silicon

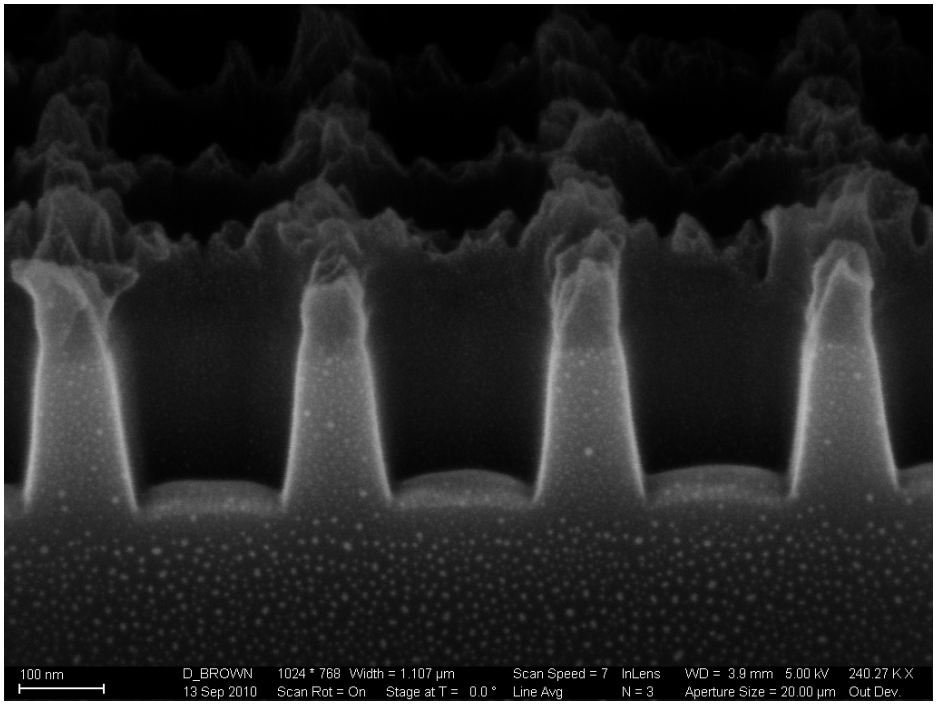
ZEP520 resist thickness = 306.5 / sin (70) = 326 nm

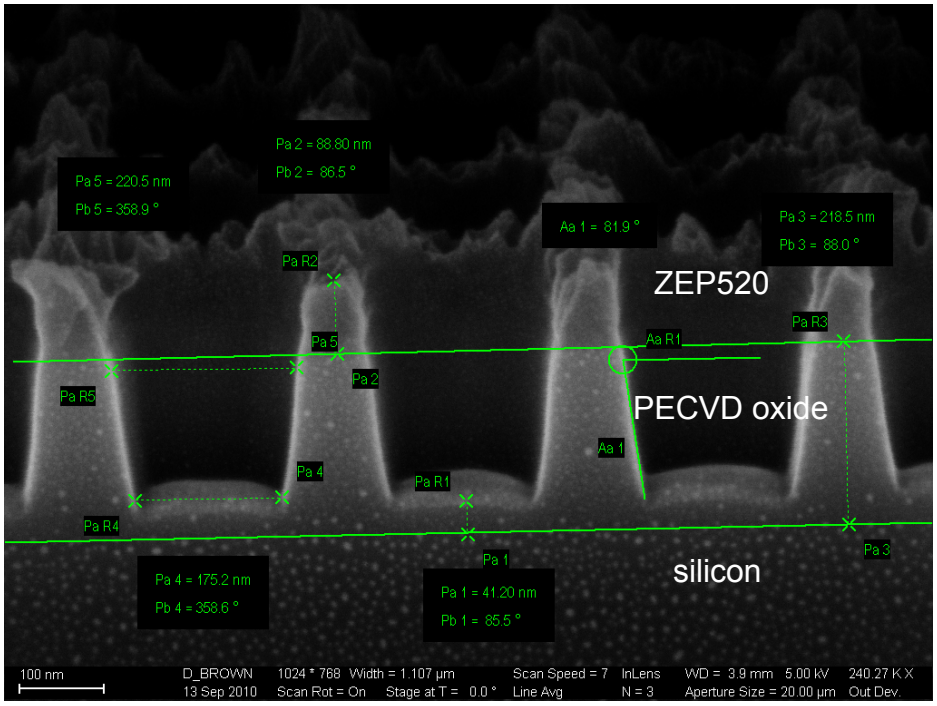
PECVD oxide thickness = 218.9 / sin (70) = 233 nm

top dimension = 219 nm

bottom dimension = 250 nm

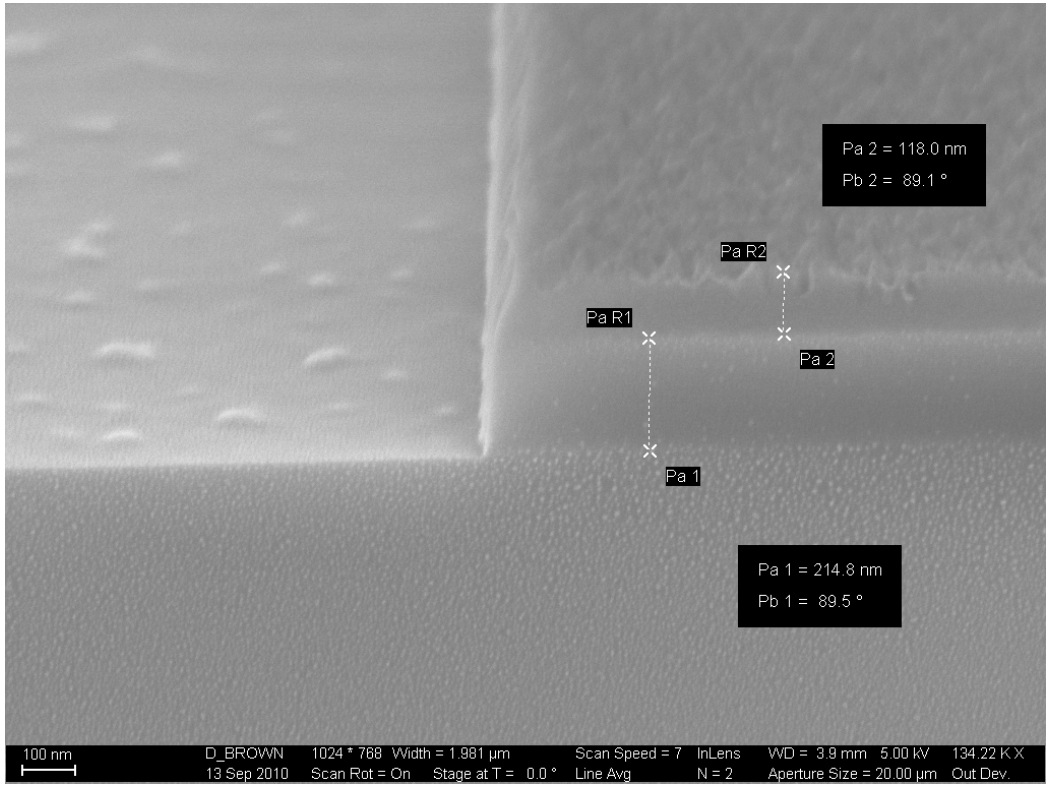
Post etch





remaining ZEP520 resist = 89 / sin(70) = 95 nm
etched ZEP520 resist = 326 – 95 = 231 nm
resist etch rate = 231/84 = 2.8 nm/sec
remaining PECVD oxide = 41 / sin(70) = 44 nm
etched PECVD oxide = 233 – 44 = 189 nm
oxide etch rate = 189/84 = 2.3 nm/sec
selectivity = 2.3/2.8 = 0.8
oxide sidewall angle = 82 degrees
top dimension = 221 nm
bottom dimension = 175 nm

Large structure etch rate



ZEP520

PECVD oxide

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silicon

- 50 x 50 um square structure on same sample as 200 nm squares is fully etched, demonstrating etch lag
- PECVD oxide etched = 215 / sin (70) = 229 nm
- oxide etch rate > 229 nm / 84 sec = 2.7 nm/sec
- ZEP520 amount etch = 326 – 118/sin(70) = 200 nm
- ZEP520 etch rate = 200 nm / 84 sec = 2.4 nm/sec
- selectivity > 2.7/2.4 = 1.1
- residue in etched area likely due to intentional underdosing of square leaving some resist residue

Summary

- large structure (50 x 50 um)
  - PECVD oxide etch rate > 2.7 nm/sec
  - ZEP520 etch rate = 2.4 nm/sec
  - selectivity = 1.1 oxide to resist

- 200 nm squares on 300 nm pitch
  - PECVD oxide etch rate = 2.3 nm/sec
  - ZEP520 etch rate = 2.8 nm/sec
  - selectivity = 0.8 oxide to resist
  - sidewall angle = 82 degrees