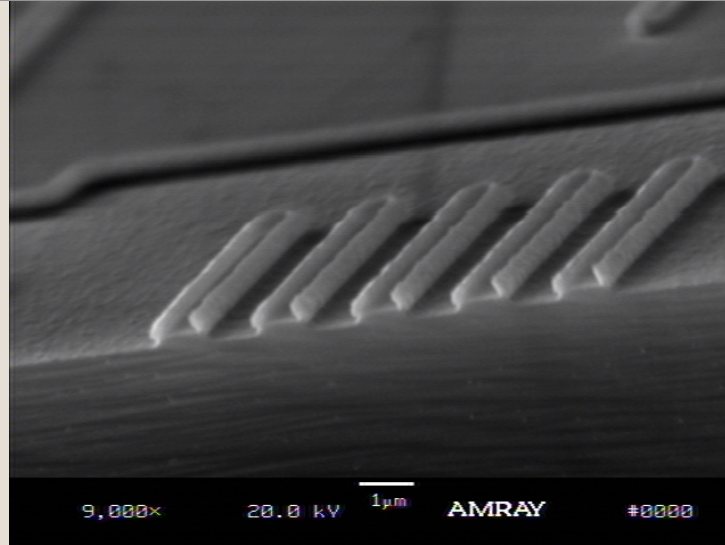


# CD Reduction Through Annular Illumination and Sidewall Spacers

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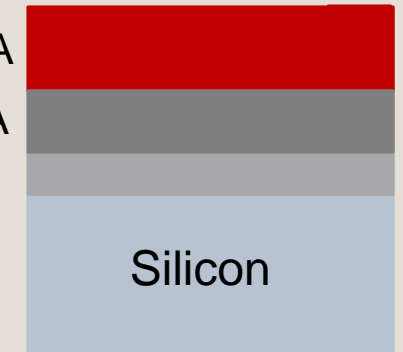


COREY SHAY

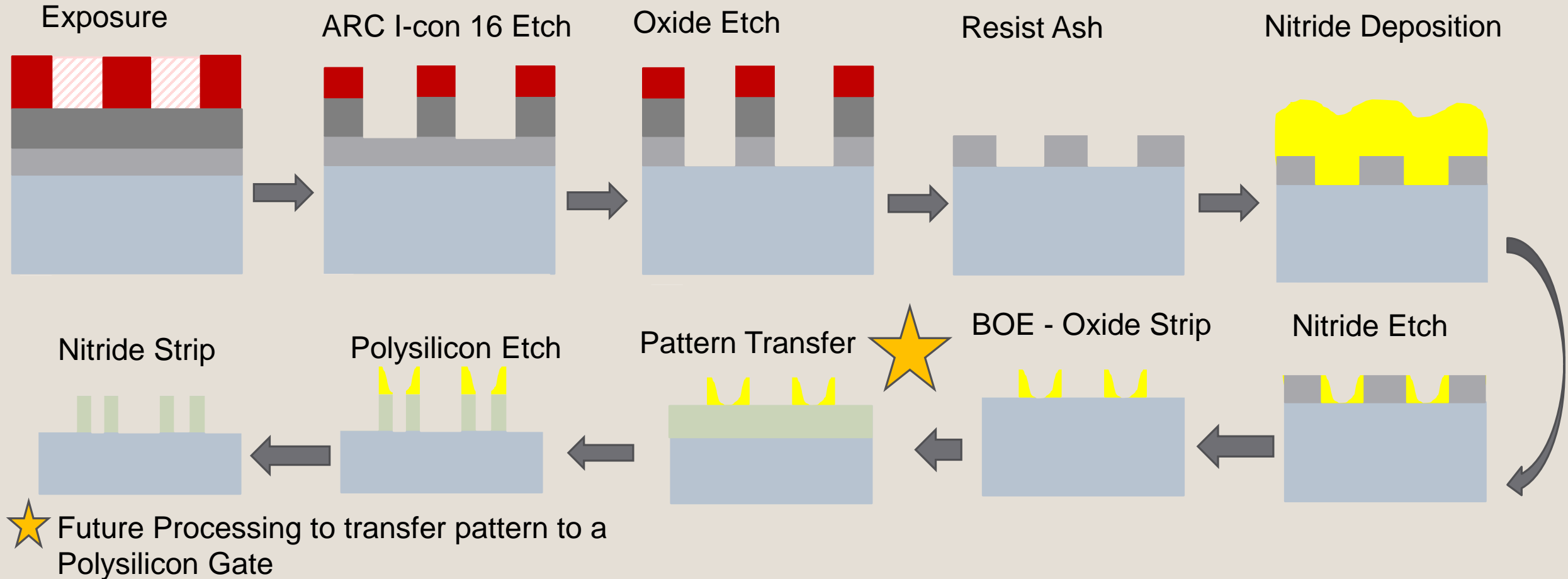
ROCHESTER INSTITUTE OF TECHNOLOGY

MCEE

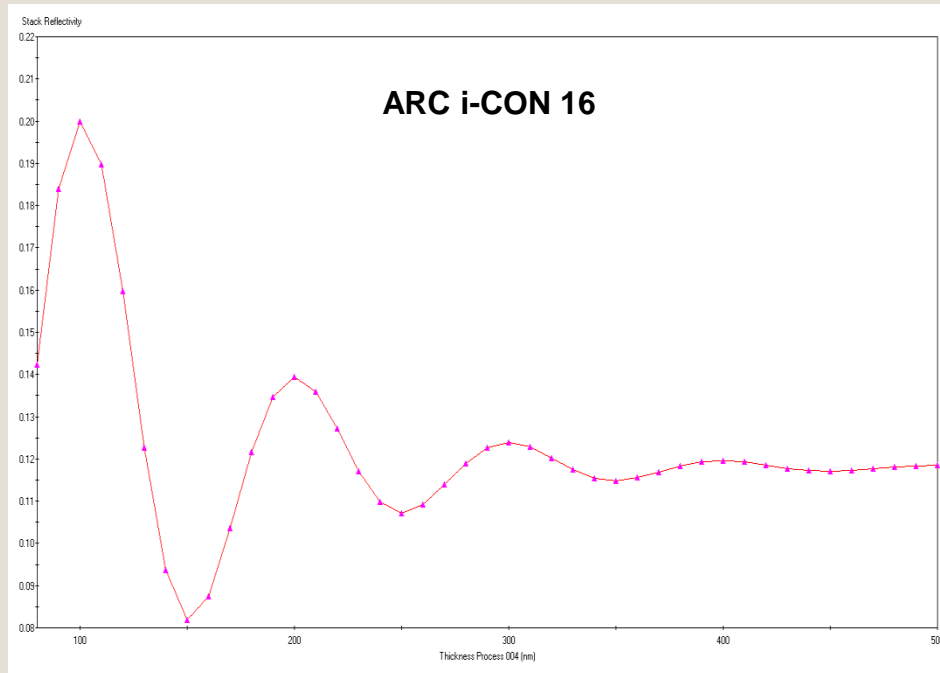
OiR 620 – 2600A  
I-Con 16 – 1600A  
Oxide – 4000A



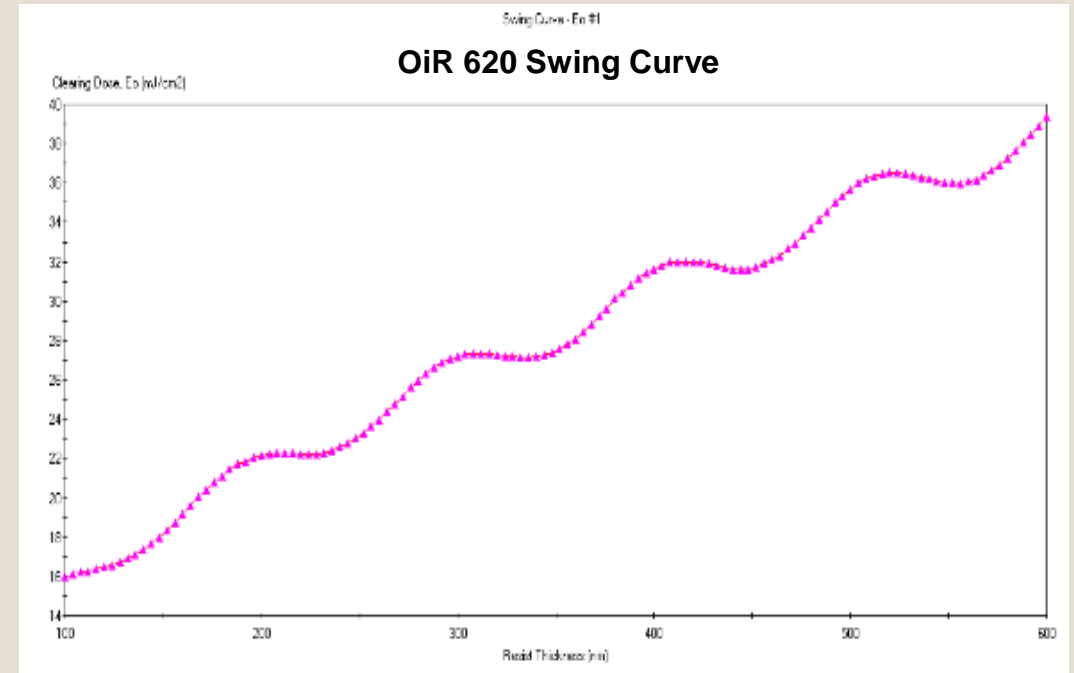
# Planned Procedure



# Film Stack Characterization



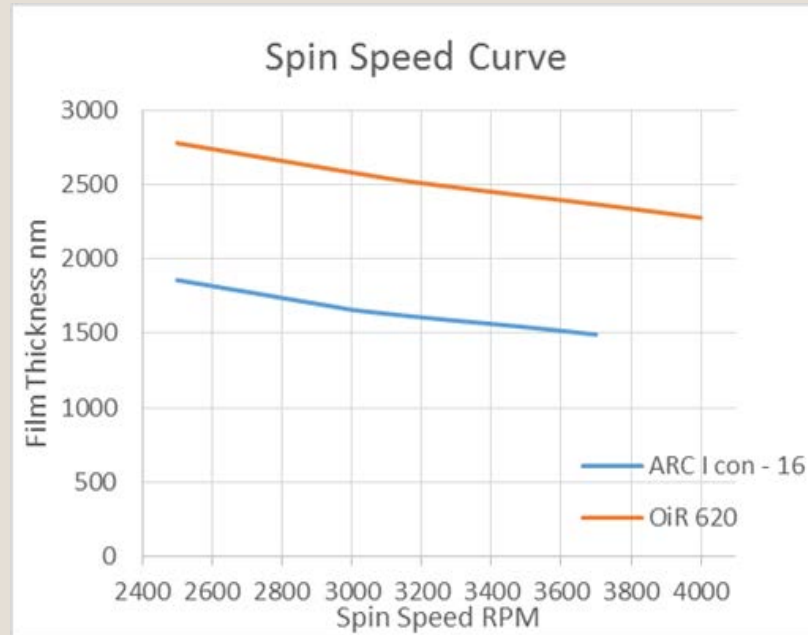
ARC i-CON 16 Minimum reflectance at 1600A film thickness.



OiR 620 film thickness is 2600A.

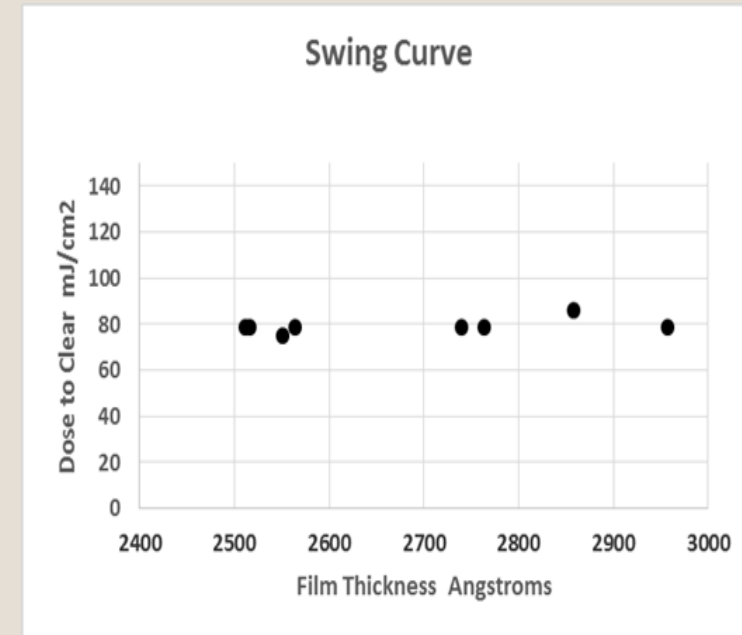
# Film Stack Characterization

Spin Speed Curve for OiR 620 and i-Con 16.



OiR 620 is diluted with PGMEA at a 1:1 ratio to achieve a film thickness below production standards.

Swing Curve

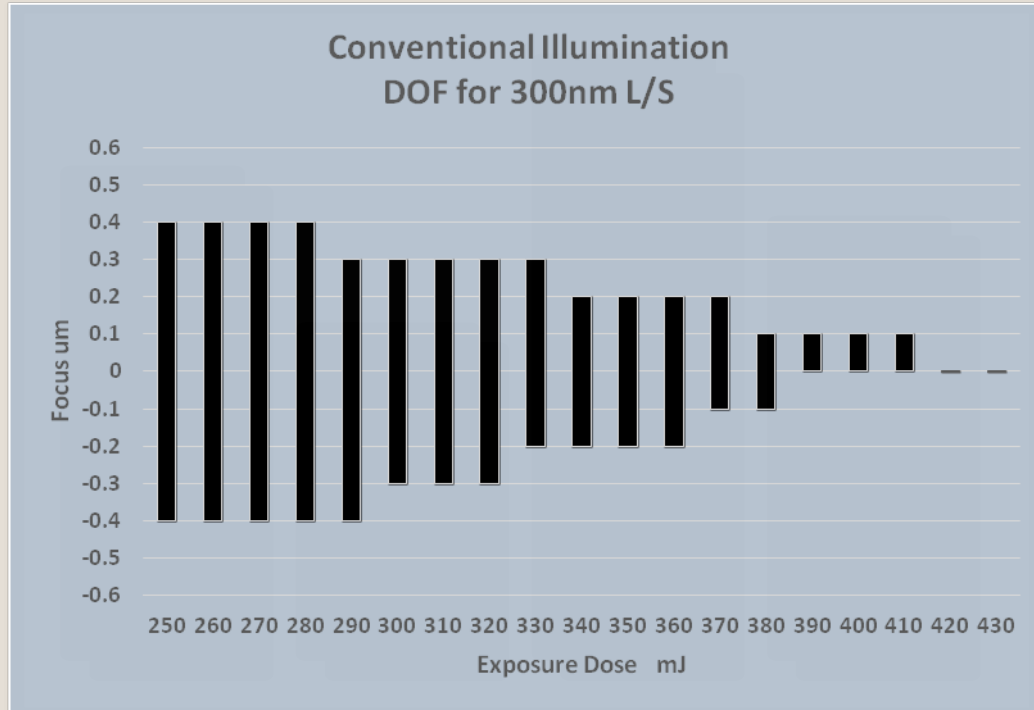


Swing curve confirms the influence of a BARC layer

# Depth of Focus Plots

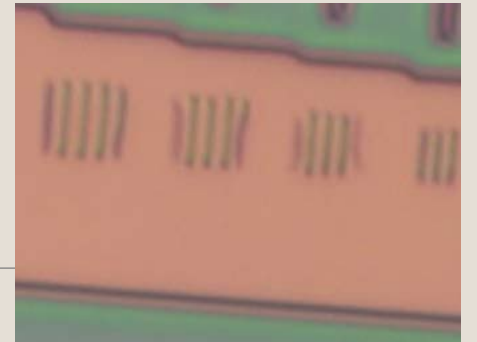
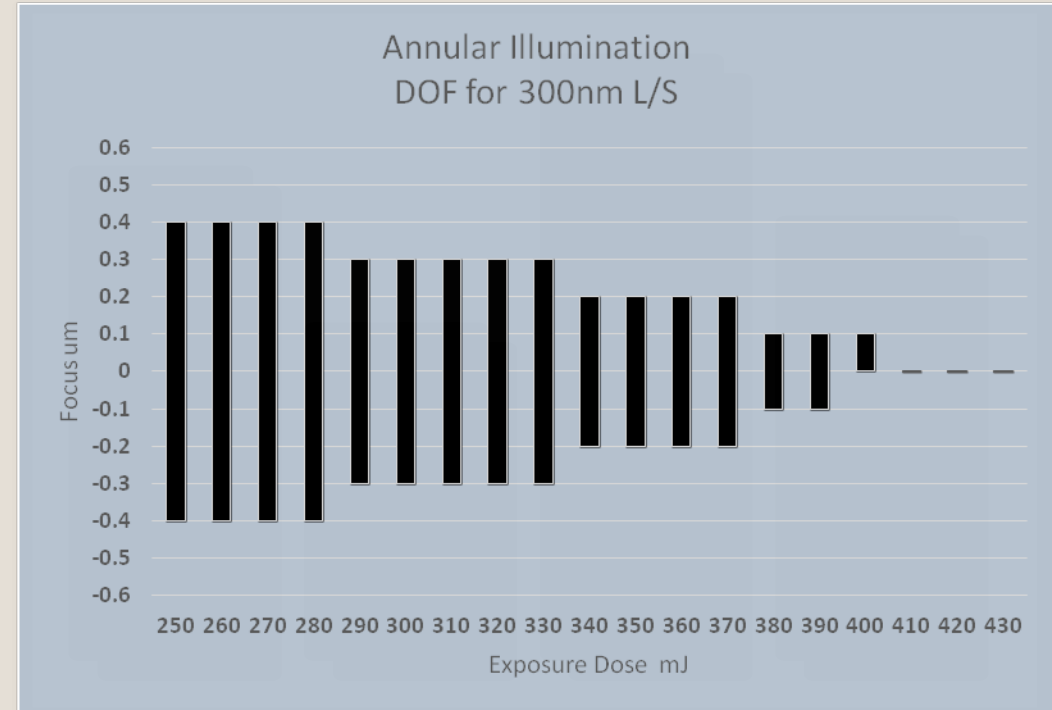
## CONVENTIONAL ILLUMINATION

NA = 0.6,  $\sigma = 0.613$



## ANNULAR ILLUMINATION

NA = 0.6,  $\sigma_0 = 0.434$ ,  $\sigma_I = 0.21$



# Etch Recipes

**I-Con 16 Etch:** Pressure: 70mT, Power: 200 W, O2: 5 sccm

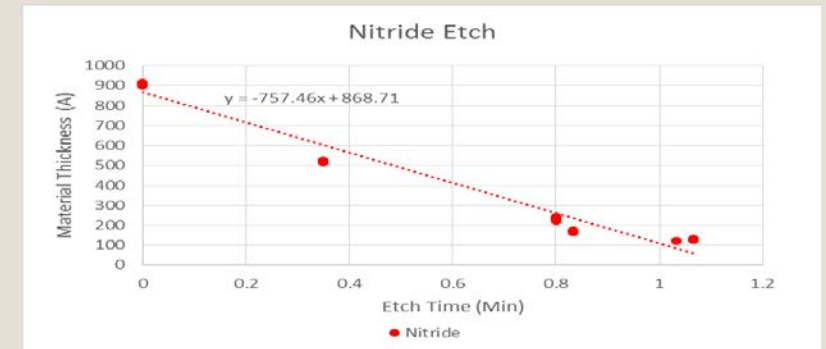
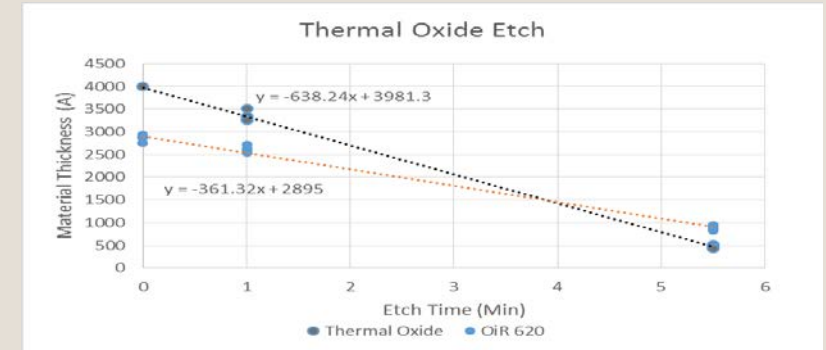
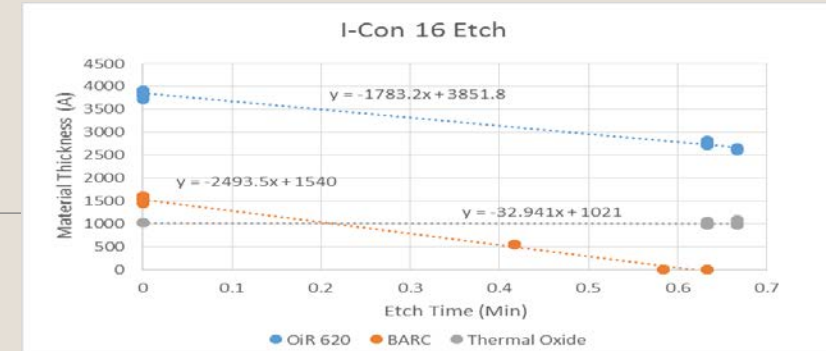
- ❑ BARC Etch Rate = 2500 A/min,
- ❑ OiR 620 = 1800 A/min
- ❑ Oxide Etch Rate = 32 A/min

**Oxide Etch:** Pressure: 70mT, Power: 250 W, O2: 5 sccm, CHF3: 30 sccm, Ar: 100 sccm.

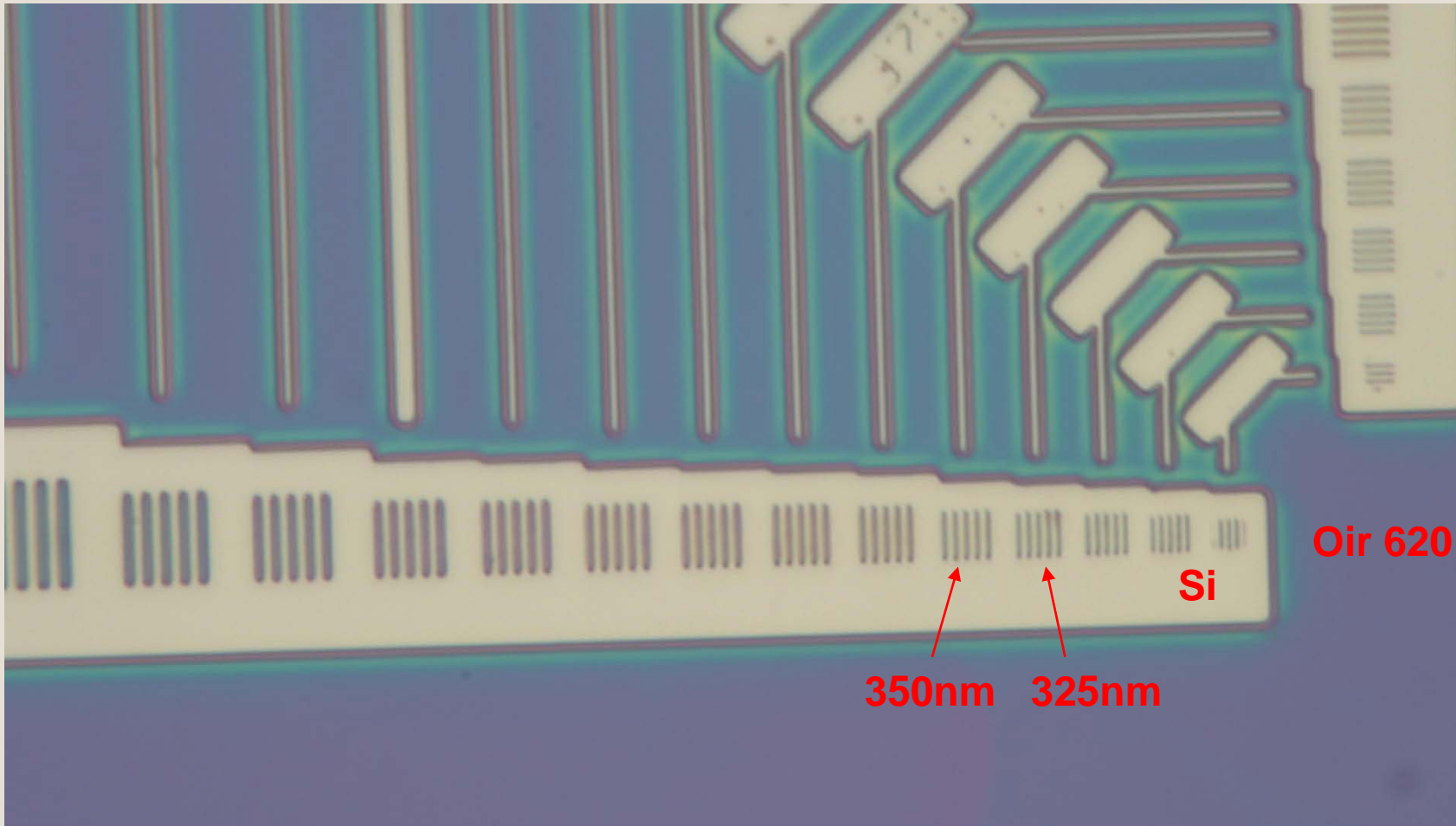
- ❑ Oxide Etch Rate = 638 A/min,
- ❑ OiR 620 = 360 A/min

**Nitride Etch:** Pressure: 70mT, Power: 250 W, O2: 0 sccm, CHF3: 30 sccm, SF6: 30 sccm, Ar: 100 sccm

- ❑ Nitride Etch rate = 757 A/min



# Exposure and Etch of i-CON 16



ANNULAR ILLUMINATION

$NA = 0.6$ ,  $\sigma_0 = 0.613$ ,  $\sigma_l = 0.037$

Resolution at 350 and 325 nm  
L/S, possibly 300nm

Oir 620

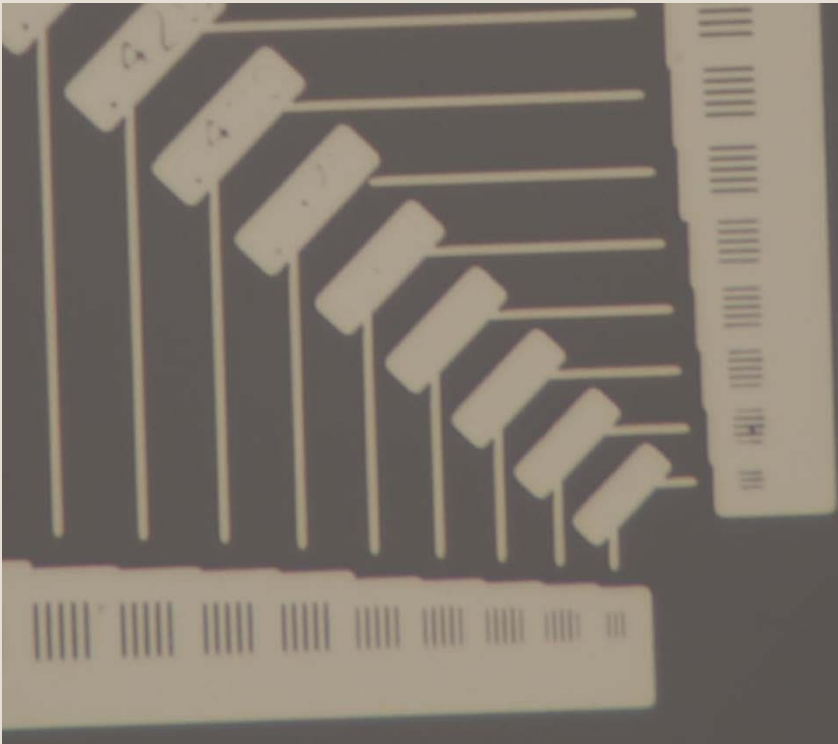
Si

350nm 325nm

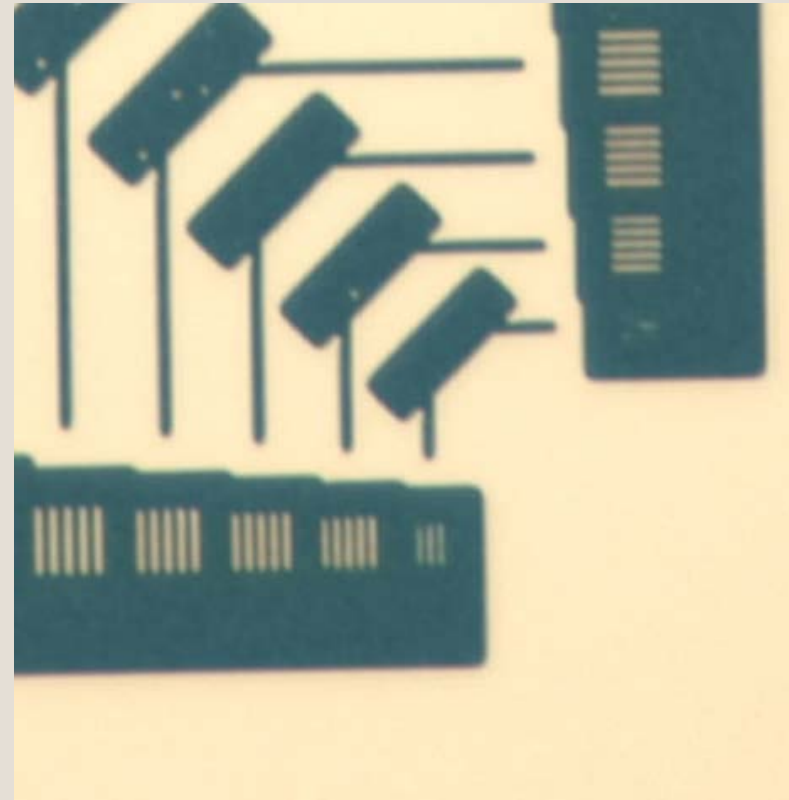
# Thermal Oxide Etch and Nitride Deposition

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HARD MASK



NITRIDE DEPOSITION WITH LPCVD

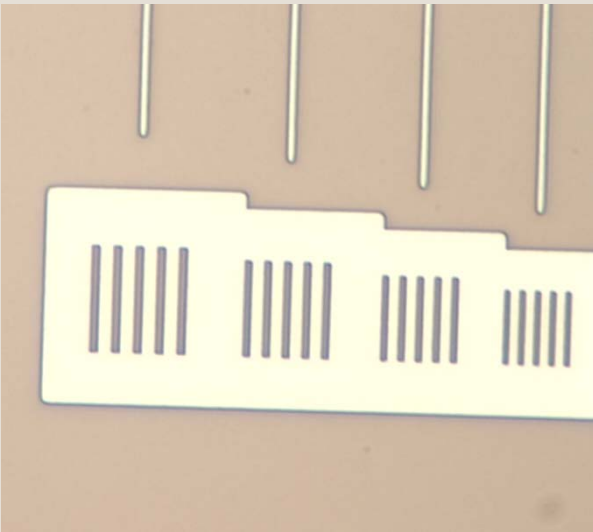




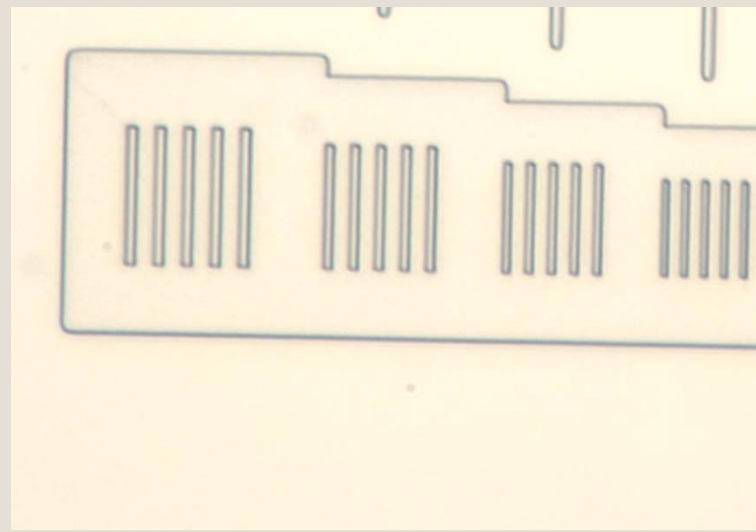
# Nitride Etch and BOE - Issues

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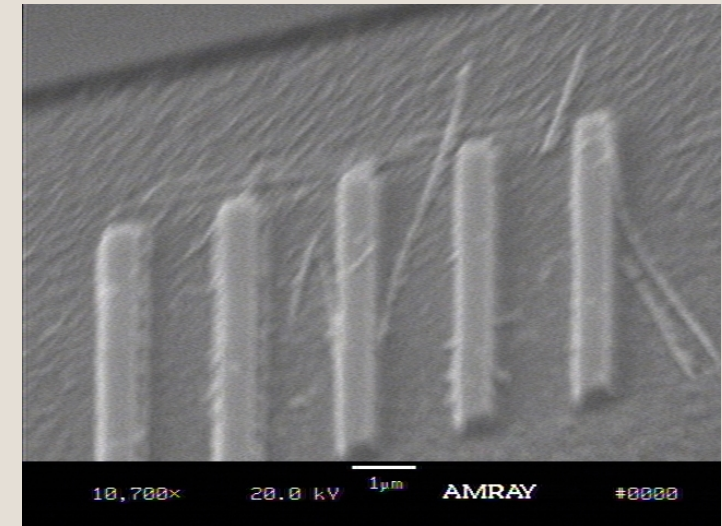
NITRIDE ETCH



BOE

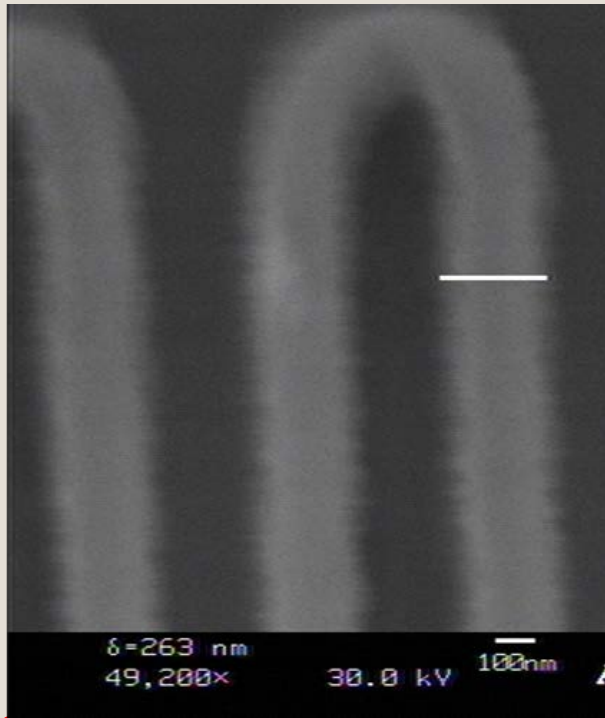


ETCHED SILICON



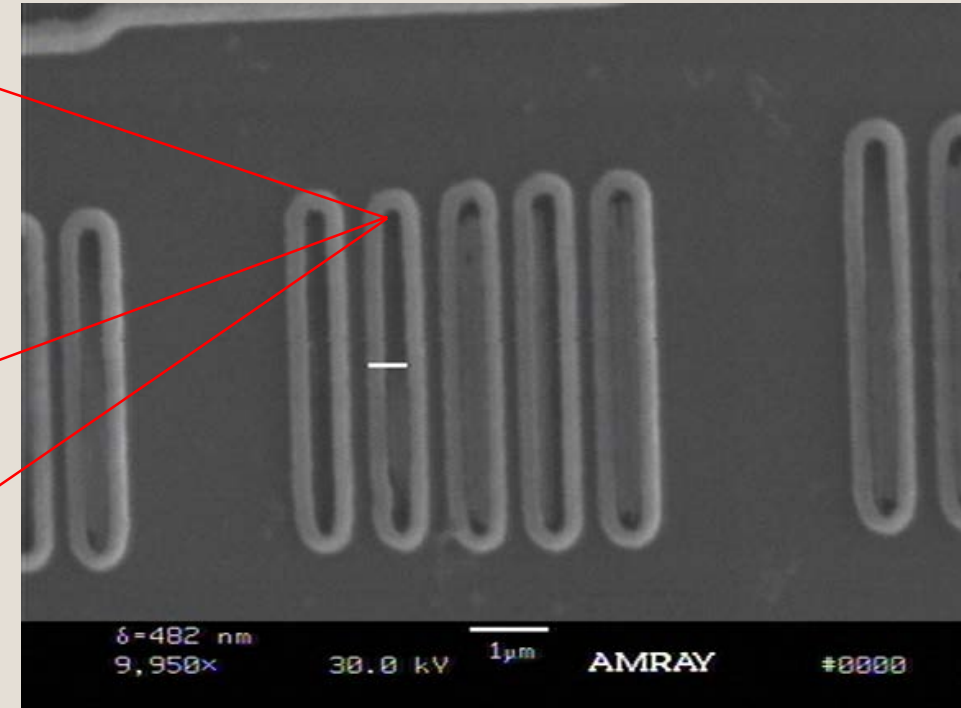
# Sidewall Spacer Formation – 2000A

2000A NITRIDE THICKNESS



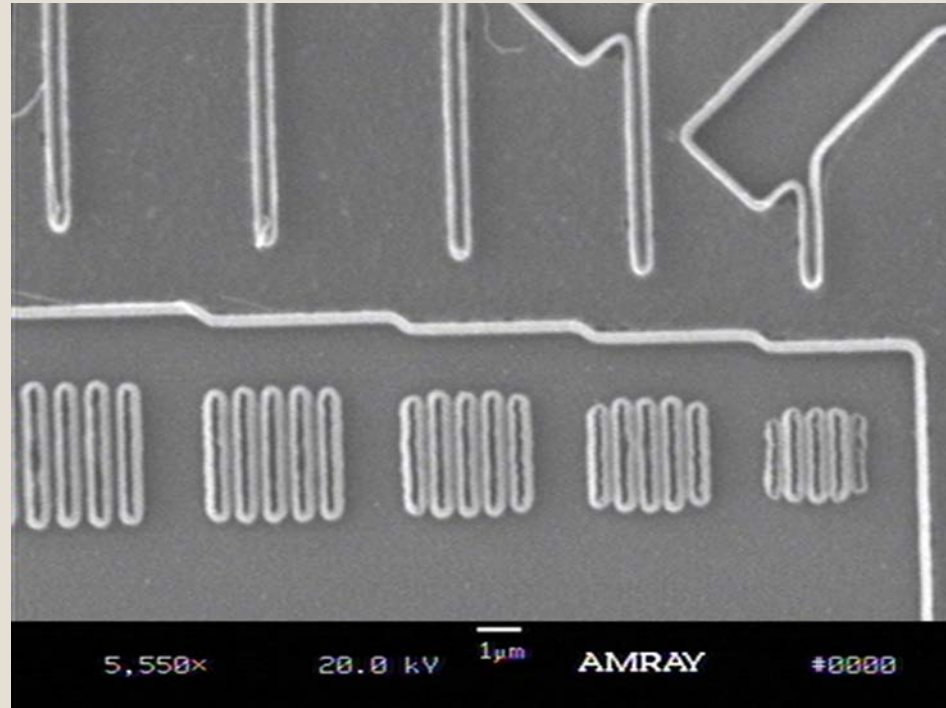
500 NM MASK FEATURES

263 NM SIDE WALL SPACER.



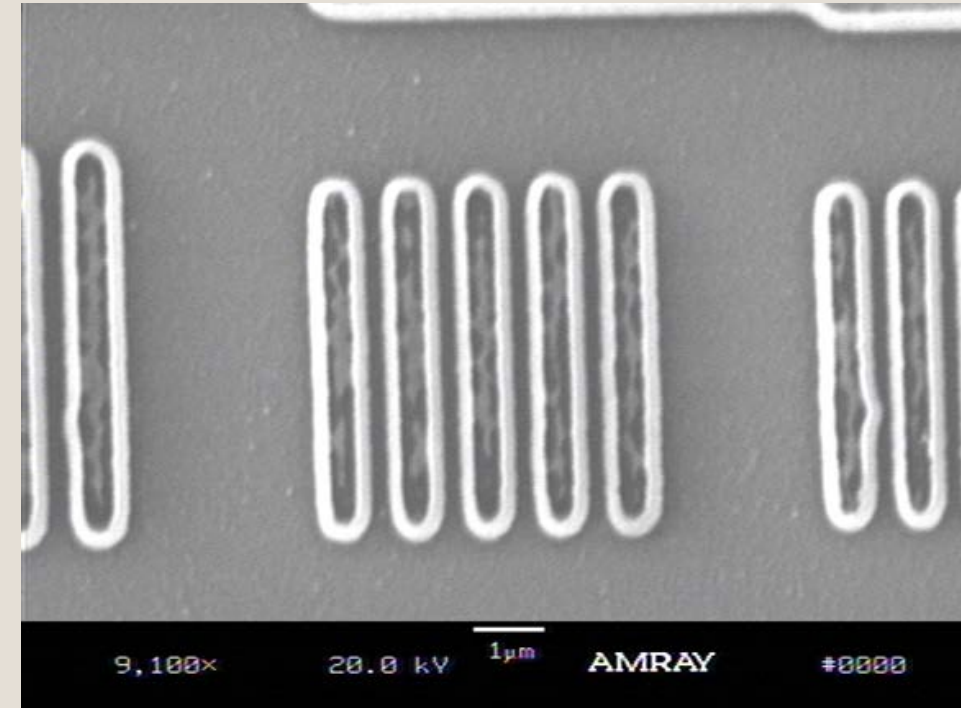
# Sidewall Spacer Formation – 1500A

1500A NITRIDE THICKNESS



500NM – MASK LINES

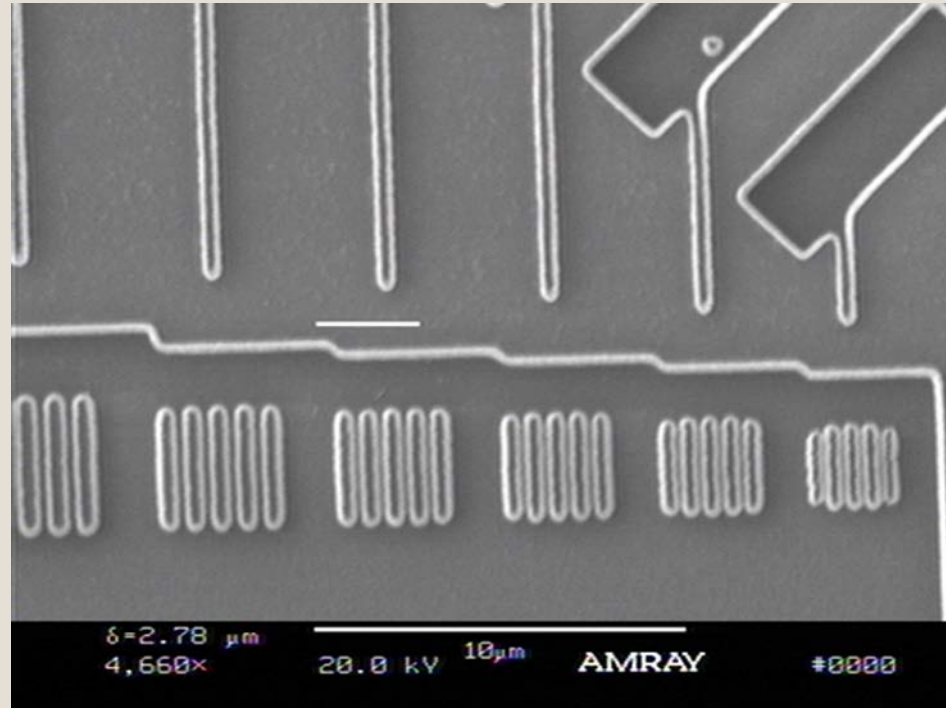
SIDEWALL SPACER – 192 NM



# Sidewall Spacer Formation – 1200A

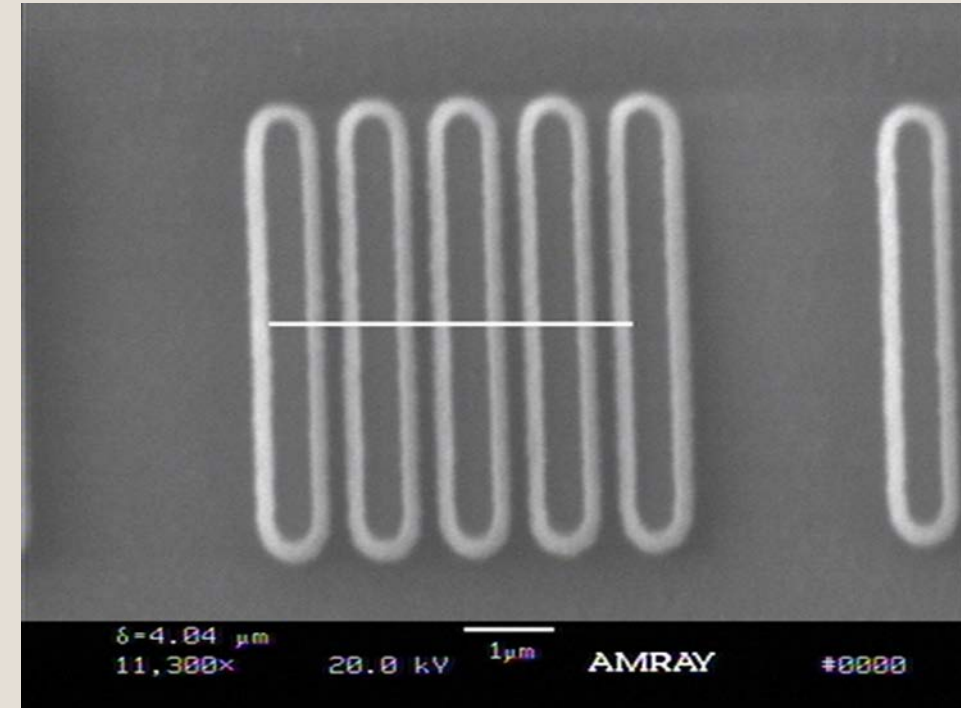
1200A NITRIDE THICKNESS

250 – 350 NM MASK FEATURES



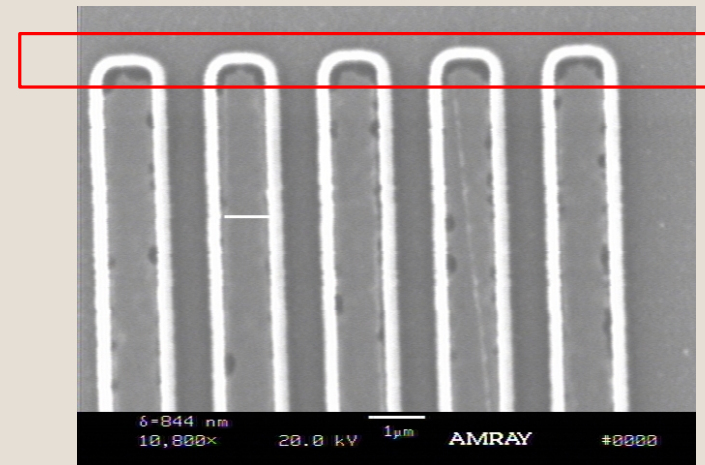
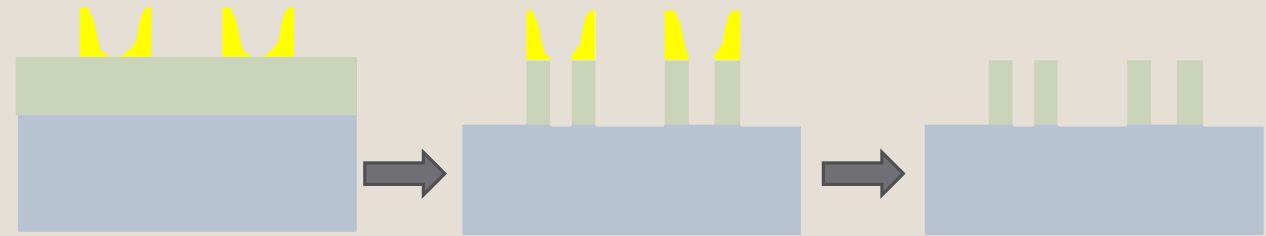
500 NM MASK LINES

205 NM SIDEWALL SPACERS



# Future Work

1. Future Processing to transfer pattern to a Polysilicon Gate
2. Optimize nitride thickness for sidewall spacers at  $<350\text{nm}$
3. Industry uses a second litho step to image and etch horizontally to remove SWS ends.



Litho Etch to remove feature ends and create vertical lines

# Acknowledgements

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- Dr. Ewbank
  - Dr. Pearson
  - Patricia Meller
  - Sean O'Brien
  - Bruce Tolleson
- 
- PROLITH by KLA-Tenco