Defect Reduction for Post Silicon Nitride Deposition Clean in MOL Sector

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GLOBALFOUNDRIES

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2020 SPCC Virtual Conference

Presentation Outline

- **Introduction to MOL sector**
- Problem Statement
- Results and Discussion
- Conclusions
- Future Work

Function of the MOL

The **M**id **O**f **L**ine provides:

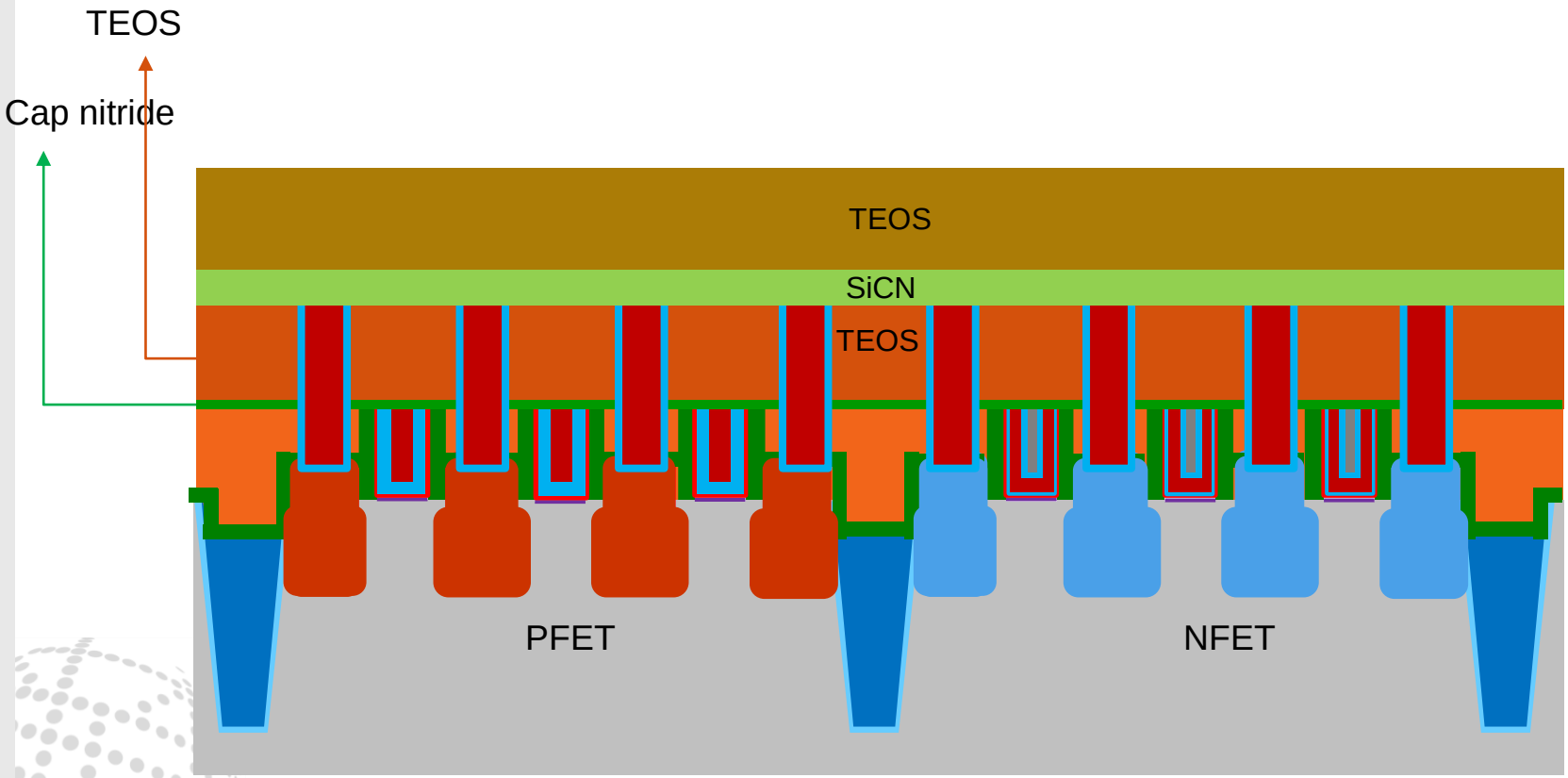
- **Strain layers (optional) for enhanced device performance**

- **Interlayer dielectric (ILD) insulation between devices and BEOL**

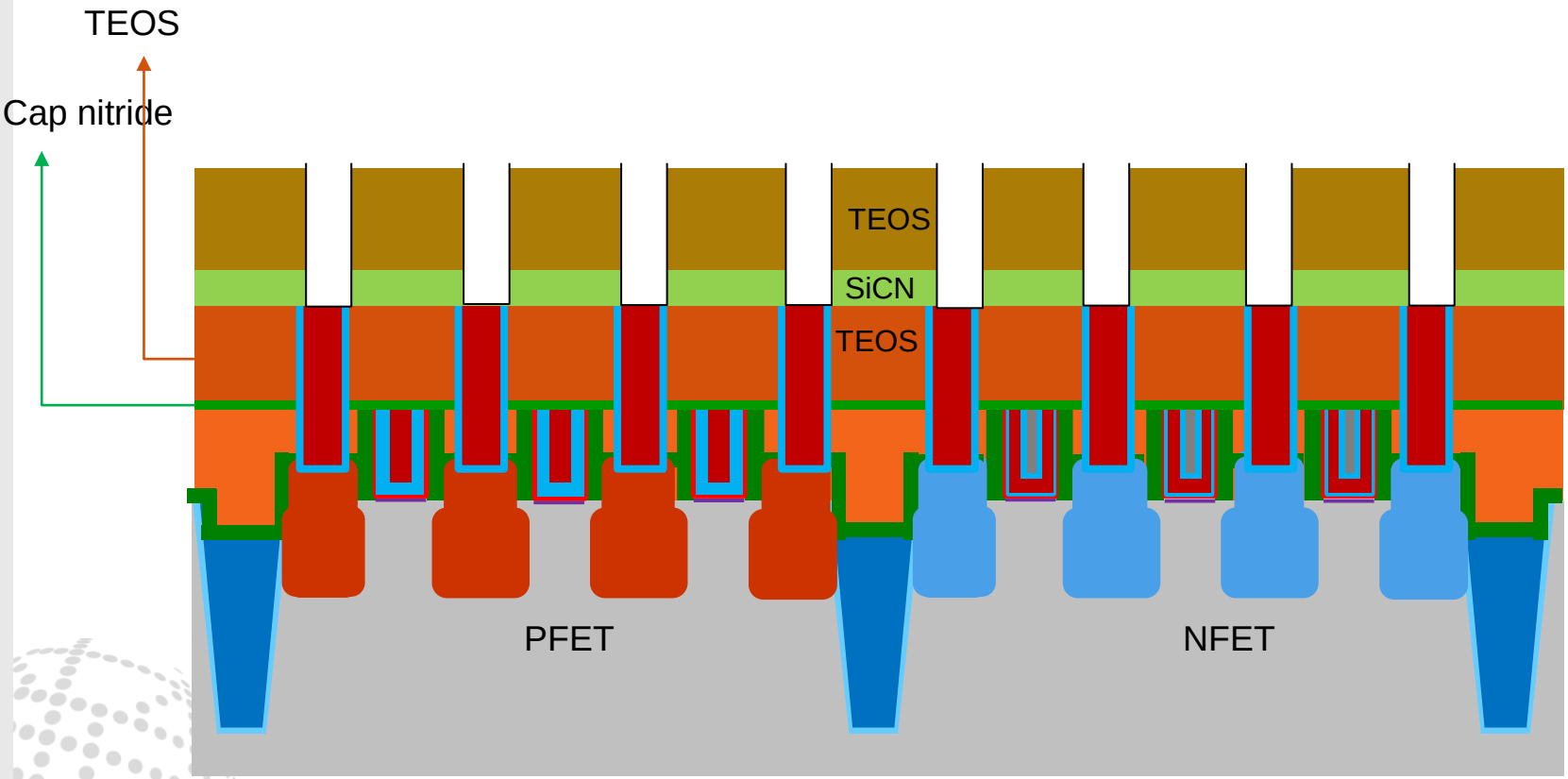
- ***W contacts to***
  - → gates
  - → source / drain regions
  - → resistors
  - → substrate diodes

} nonFETs

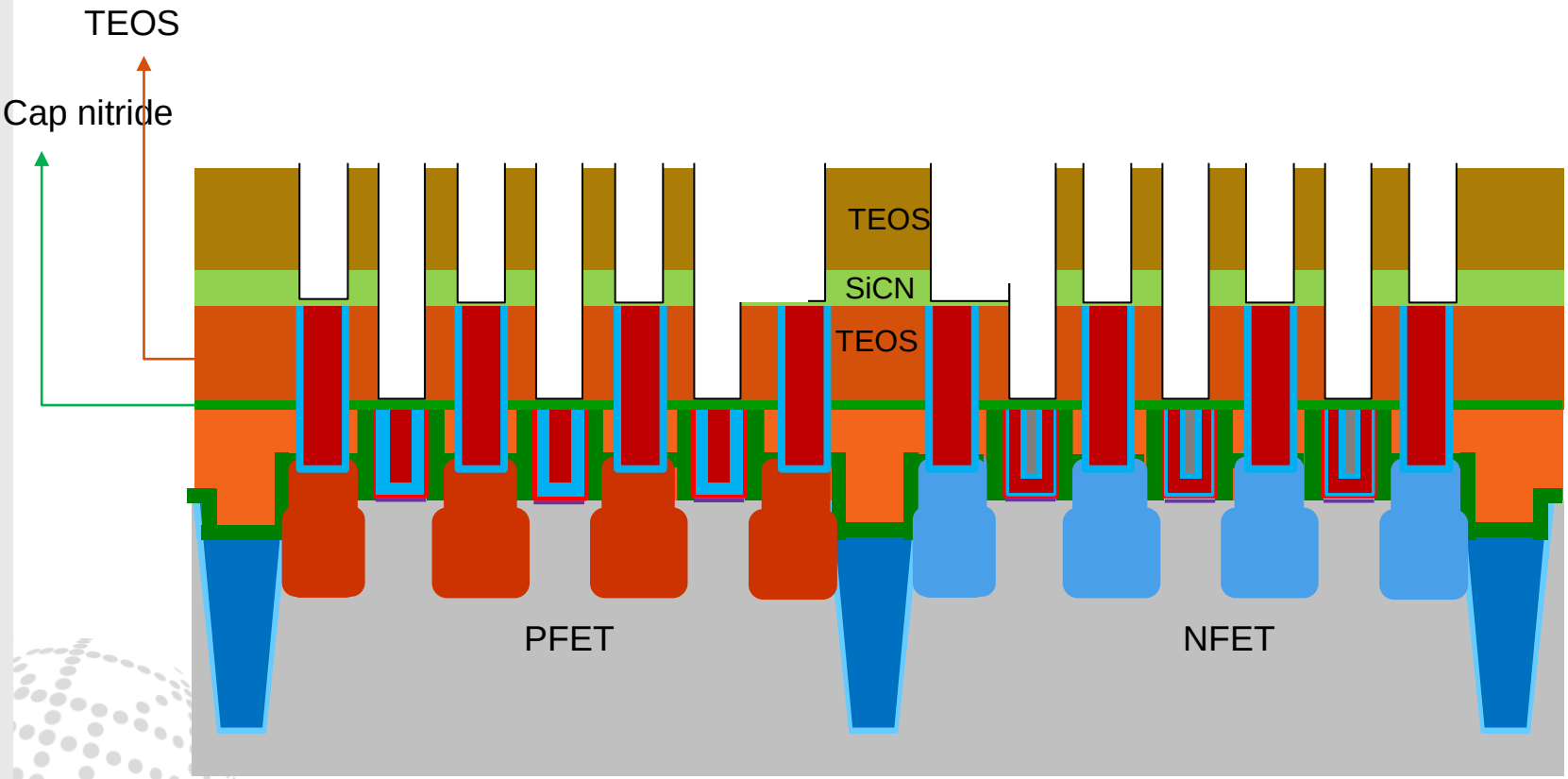
Simplified MOL Process Flow



Simplified MOL Process Flow



Simplified MOL Process Flow



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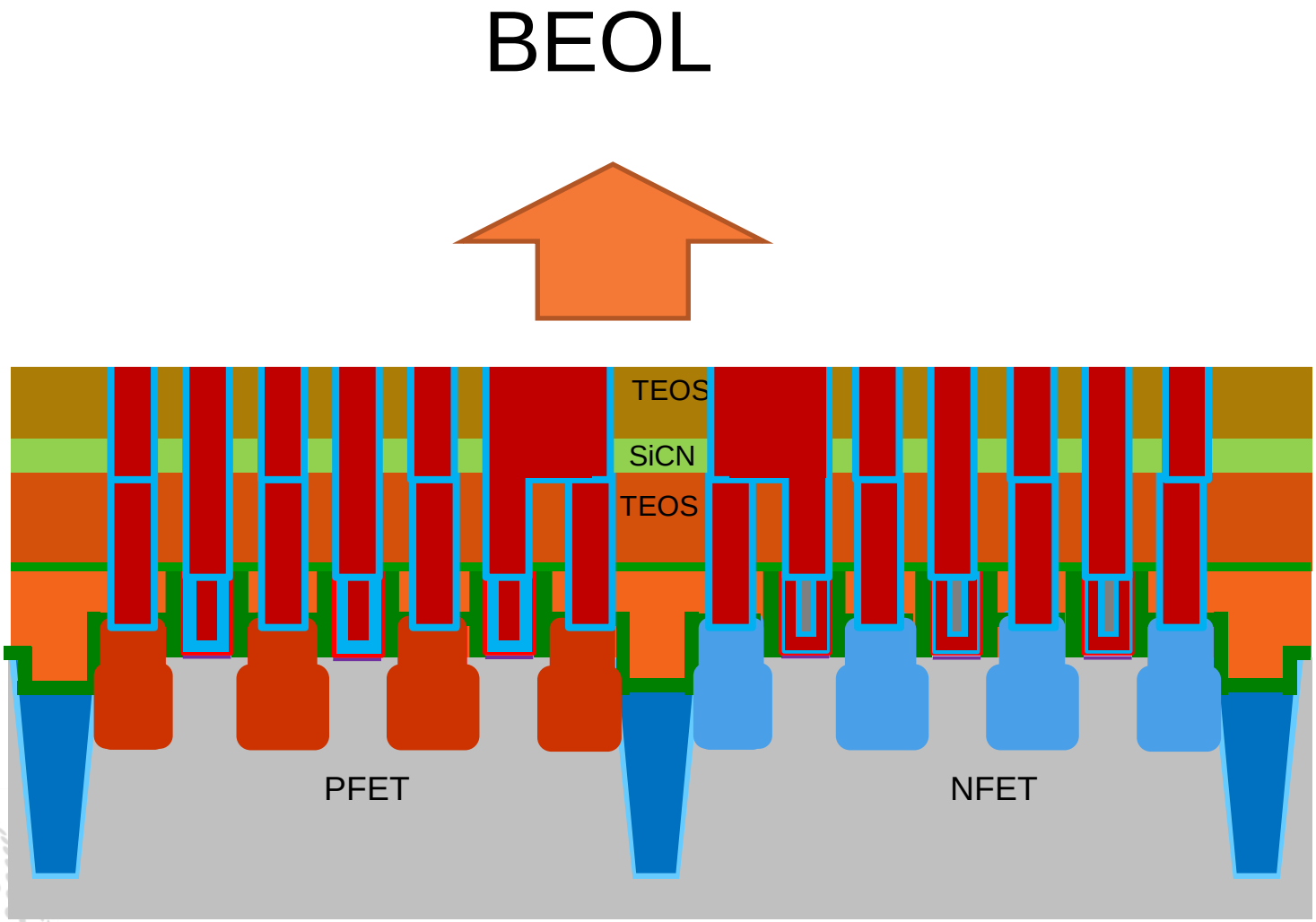

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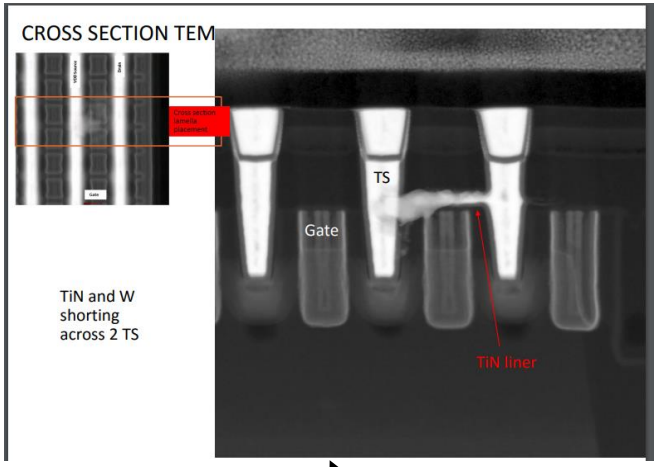
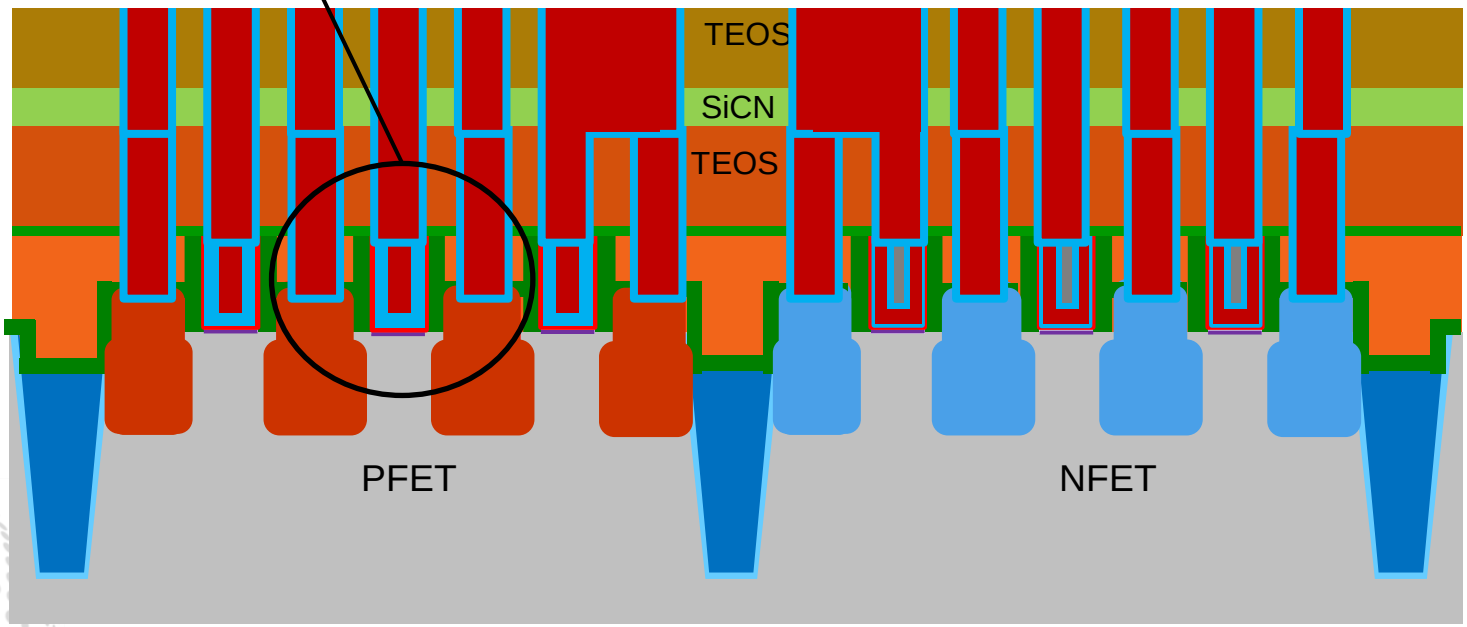
Problem Statement



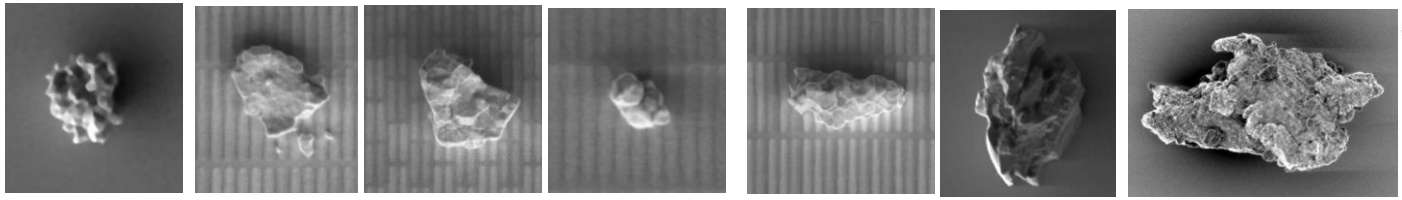
TS-PC short

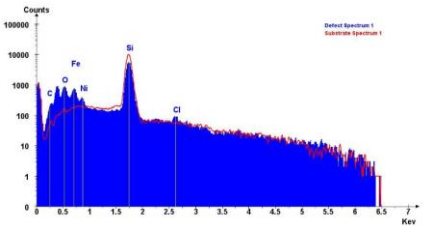
❖ Proposed mechanism
Defects on nitride surface etched away doing patterning, generating run paths for liner/metal movement



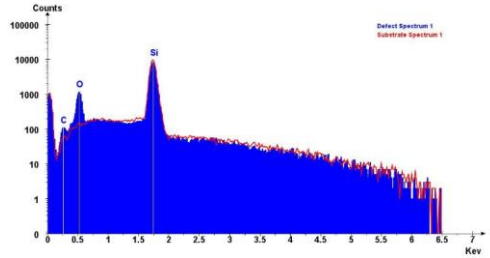
Defects generation during nitride deposition

Surface particles

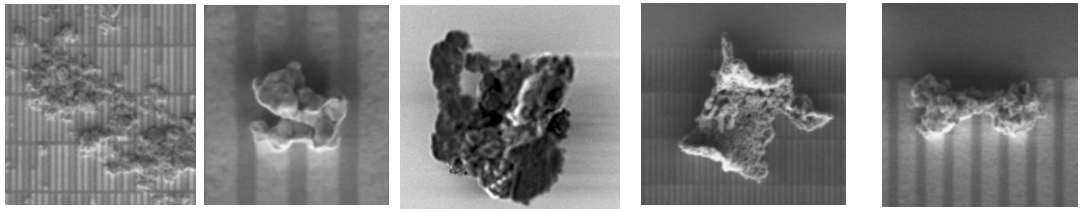


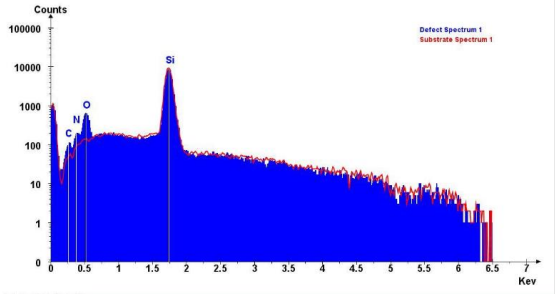


*not to scale



Organic particles





*not to scale

- Surface particle and organics are non exclusive, they often classified together
- Both defects sometimes contain minor amount of metals, such as Al, Fe, Ni

Post nitride deposition clean important

- Post nitride deposition requires a wet clean process to remove surface defects

Proposed Solution

- Improve post nitride deposition cleaning by focusing on organic related defects removal
- POR chemistry: basic chemistry with oxidizer

  pH 8-11, good for particle removal
- Goto chemistry: acidic chemistry with oxidizer

  pH 2-4, good for organic removal

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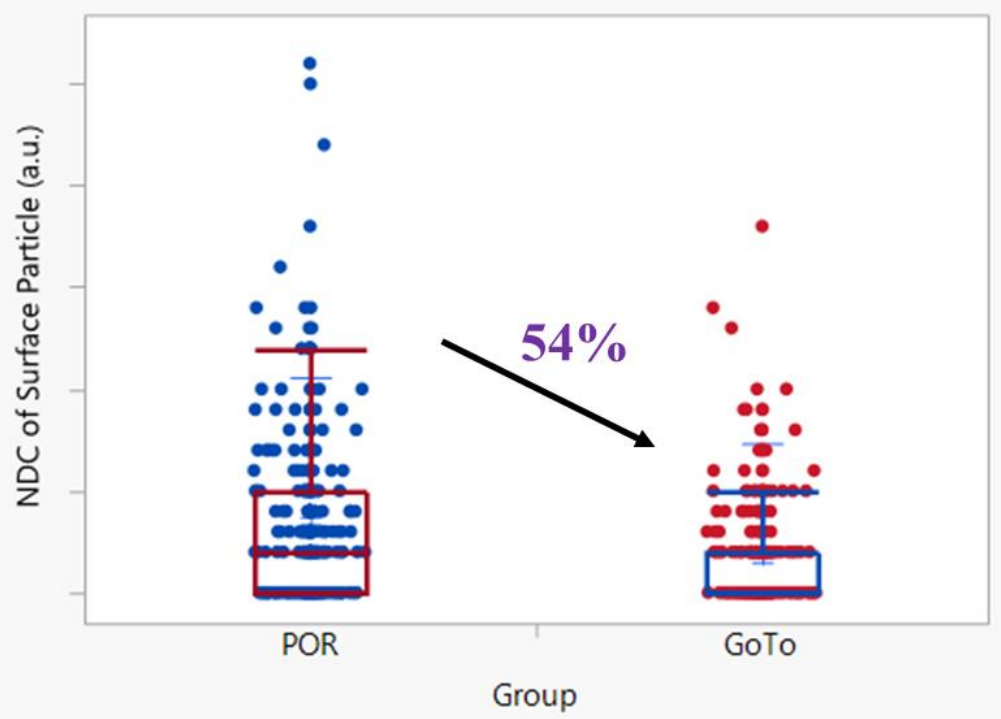
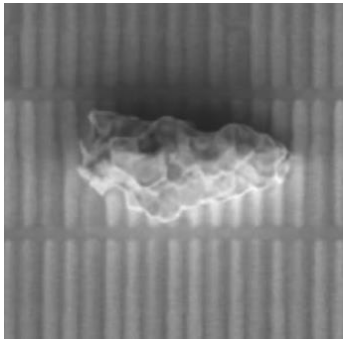
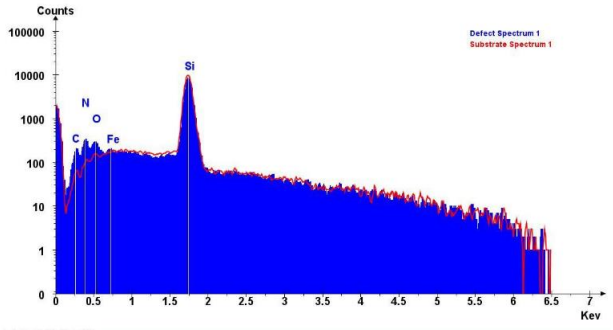
Surface Particle Reduction

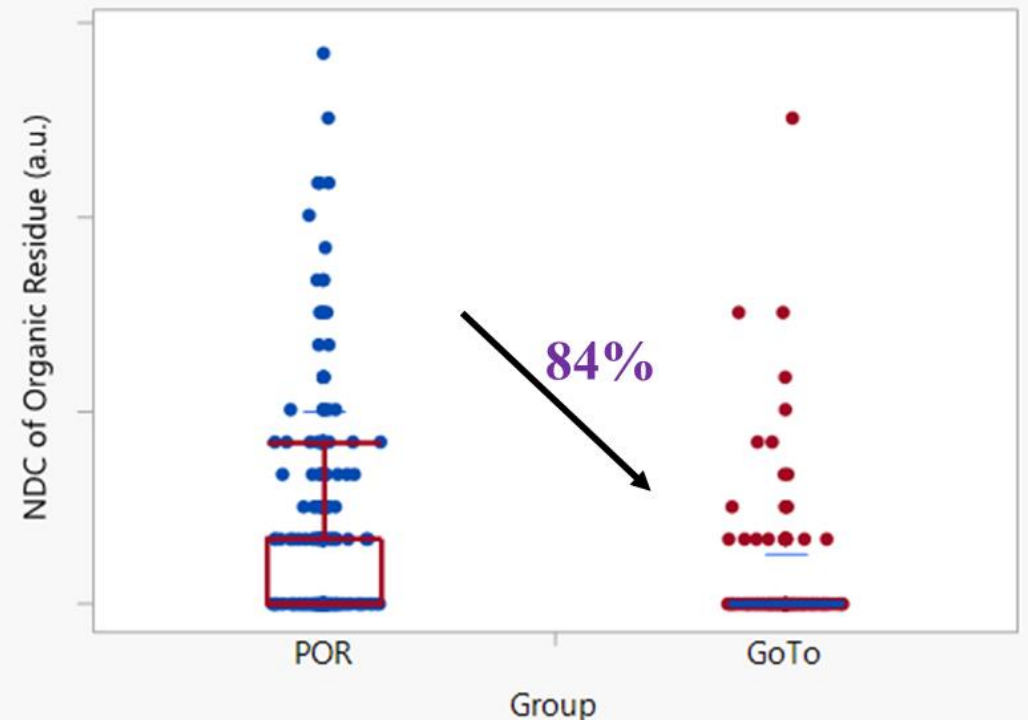


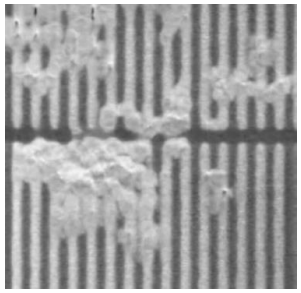


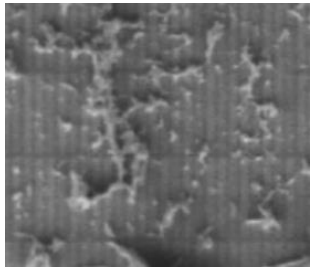


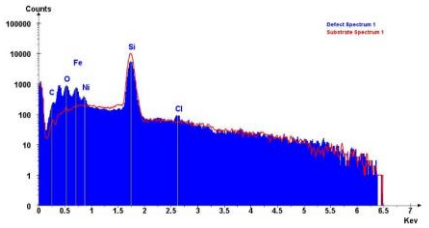
- Goto chemistry significantly reduces surface particles
- Silicon nitride surface is hydrophobic in nature, attracting particles
- Goto chemistry effectively oxidize nitride surface to form a thin oxide layer, reducing hydrophobicity

Organic Reduction



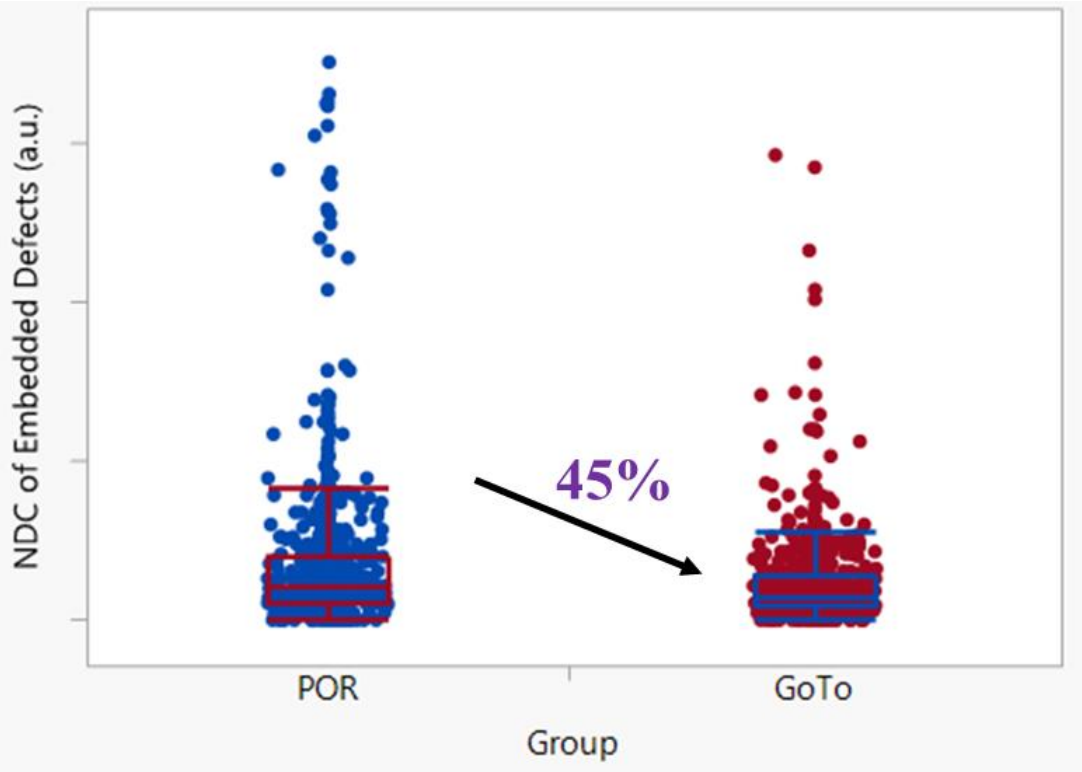


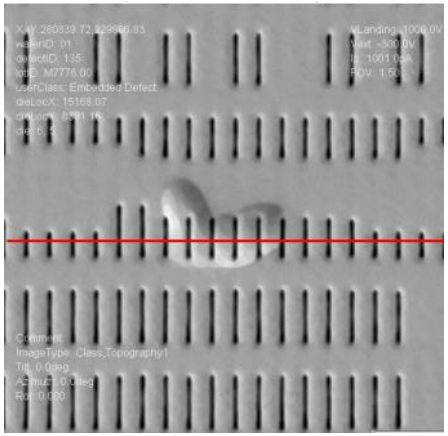




- Defects contains significant organic component evident from the carbon, nitrogen and oxygen peaks and some metals
- Goto chemistry able to oxide organic component, forming soluble –OH/-COOH surface groups, enhance particle removal

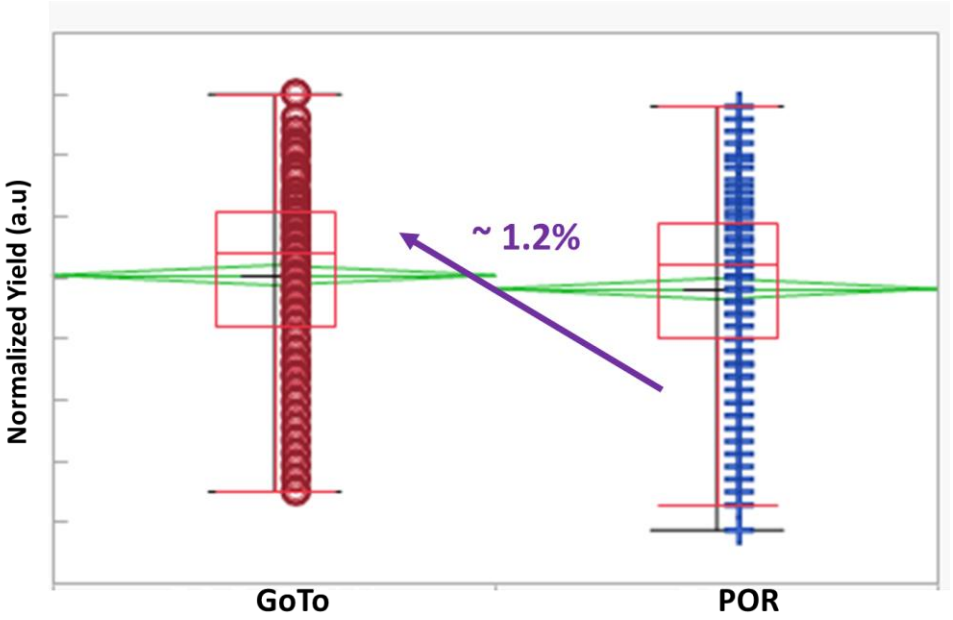
Embedded Defects Reduction

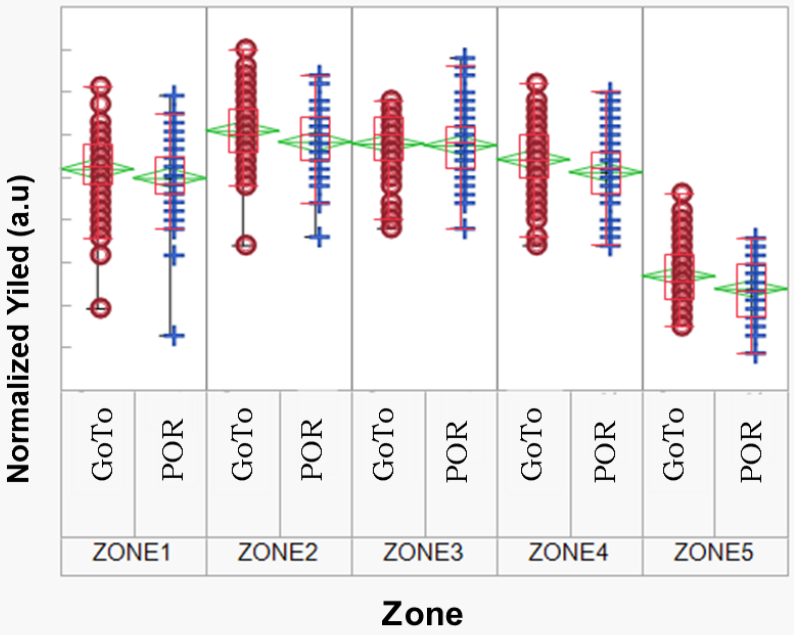




- Embedded defects coming from surface defects during nitride deposition, coated with subsequent layer deposition
- TEOS deposition reveals smaller defects not picked up in prior scans

Yield Improvement





- Defect reduction translate to yield improvement
- Goto chemistry increase yield by ~1.2%
- Yield improvement consistent across all zones from wafer center to edge

TS-PC shorts

- Shorts statistically comparable to POR, no significant improvement

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Conclusions

- Goto chemistry reduces surface particles, organics significantly
- Surface defect reduction leads to less embedded defects
- Defect reduction translates to ~1.2% yield enhancement
- Yield improvement consistent from wafer center to edge
- TS-PC short not improved based on current data

Future Work

- Process recipe improvement (such as dispense time, flow rate, spin speed)

Thank you