

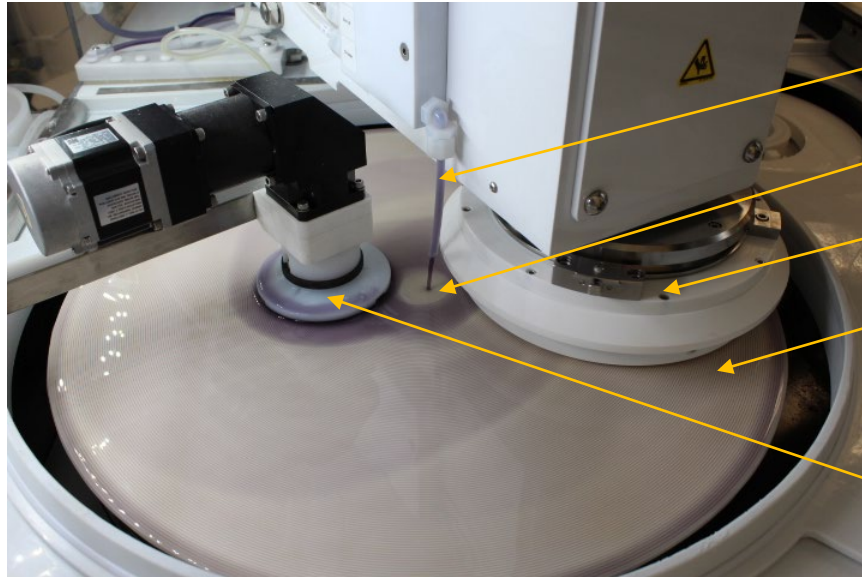
Slurry Injection System (SIS) Implementation in Dielectric and Metal CMP for III-V Semiconductors

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STANDARD TOOL SETUP



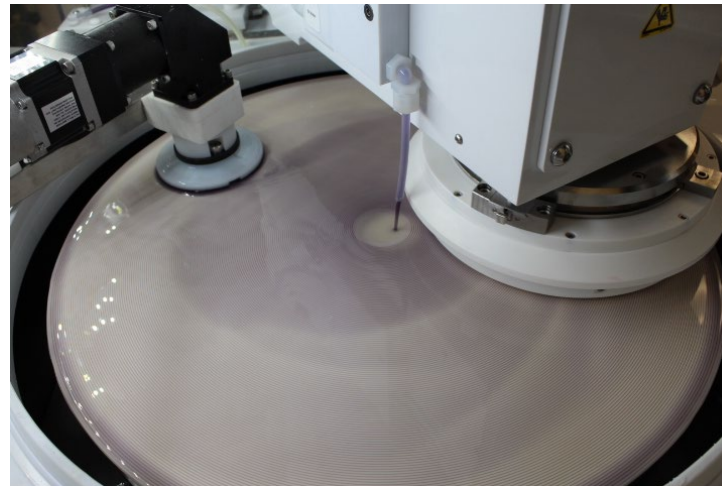
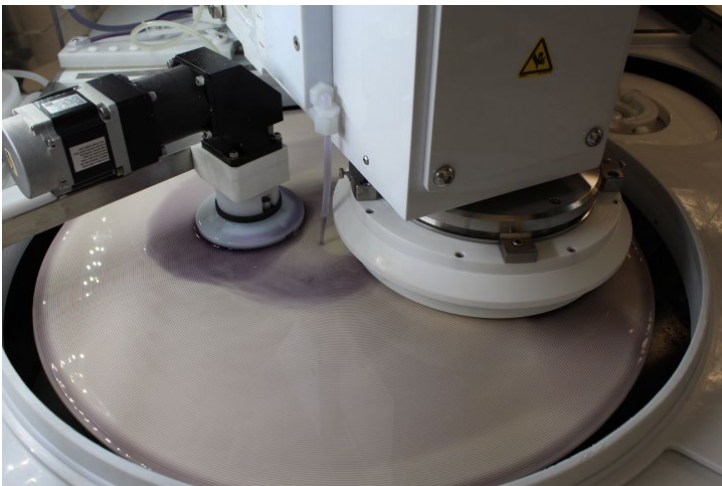
Slurry Delivery Tubing

Slurry (slurry puddle – Not as uniform with the bow wave)

Wafer Carrier Head

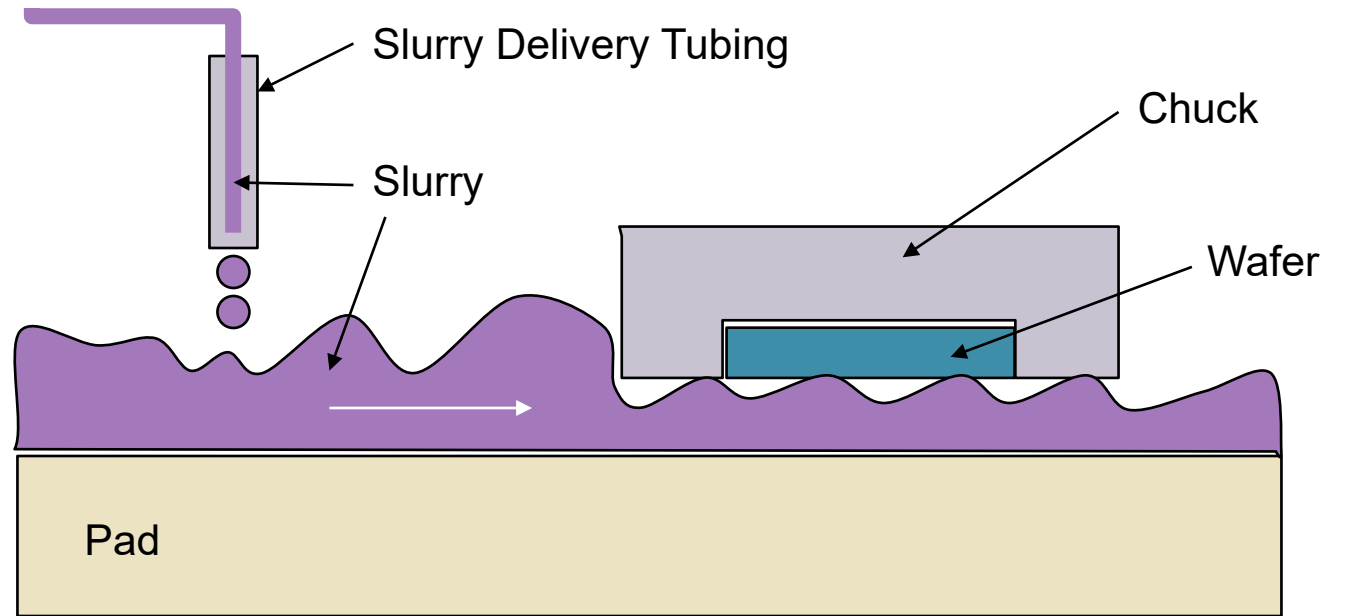
Pad

Conditioner

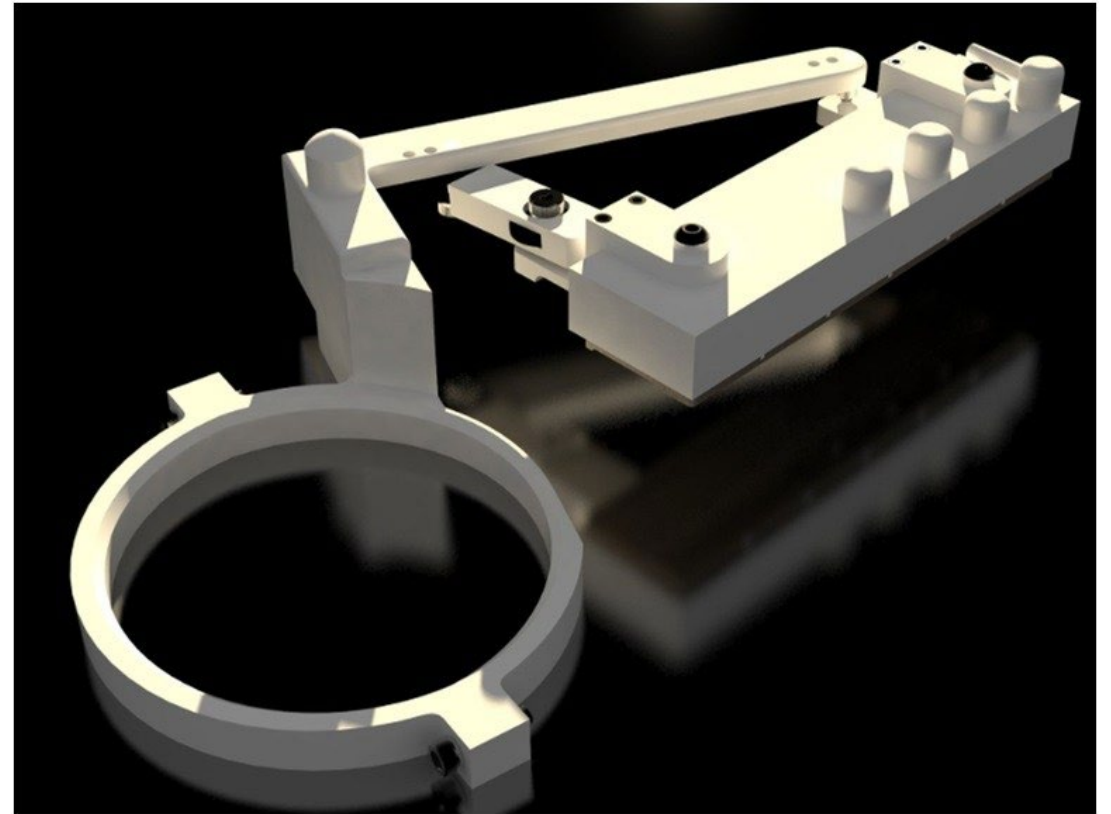
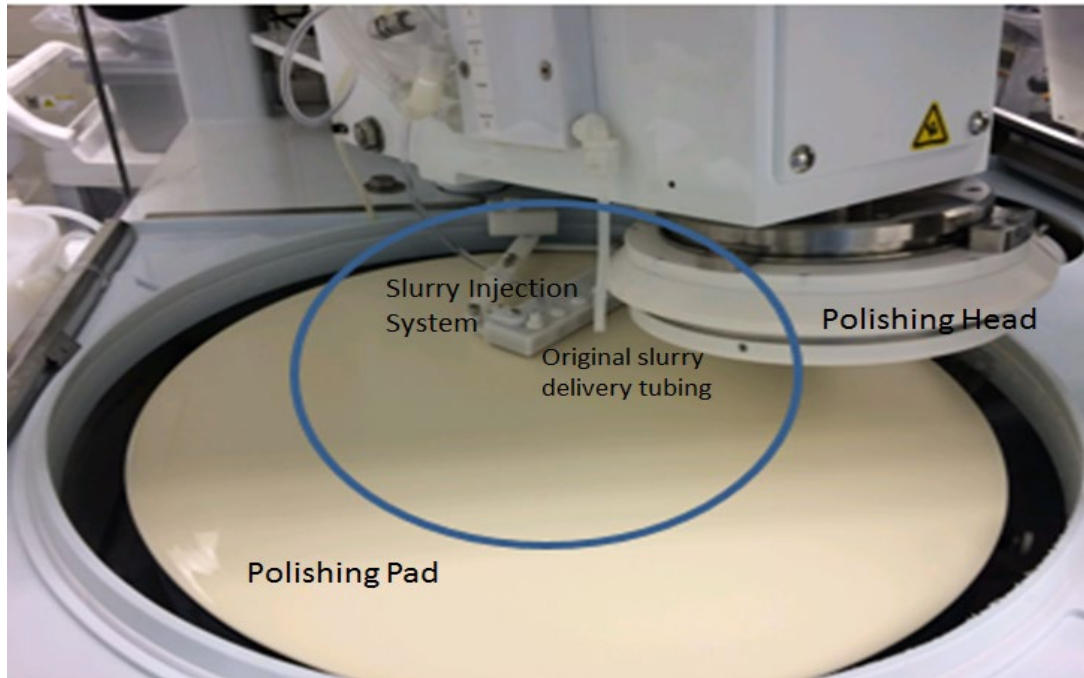


STANDARD SLURRY DELIVERY

- **Uncontrolled Slurry Distribution**
- **Bow Wave**
- **Recycled Used "Dirty" Slurry**



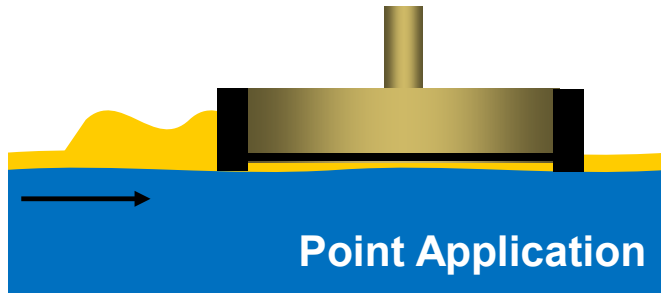
ADDITION OF SLURRY INJECTION SYSTEM (SIS)



SIS VS. STANDARD PROCESS

Standard Process

- Larger bow wave
- Made of fresh & used slurry, pad debris, particles

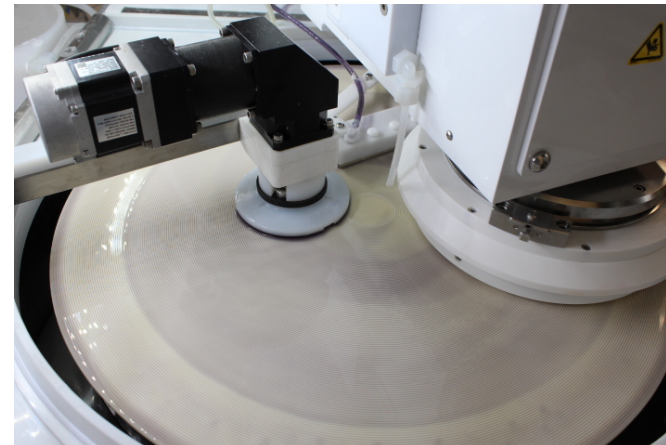
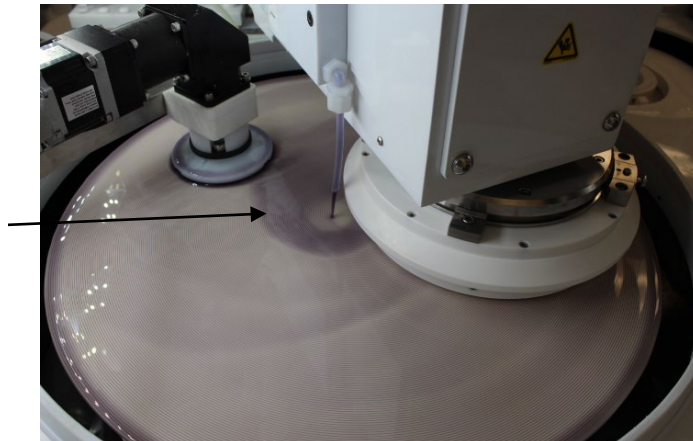


SIS Process

- Smaller bow wave
- Made of only fresh slurry

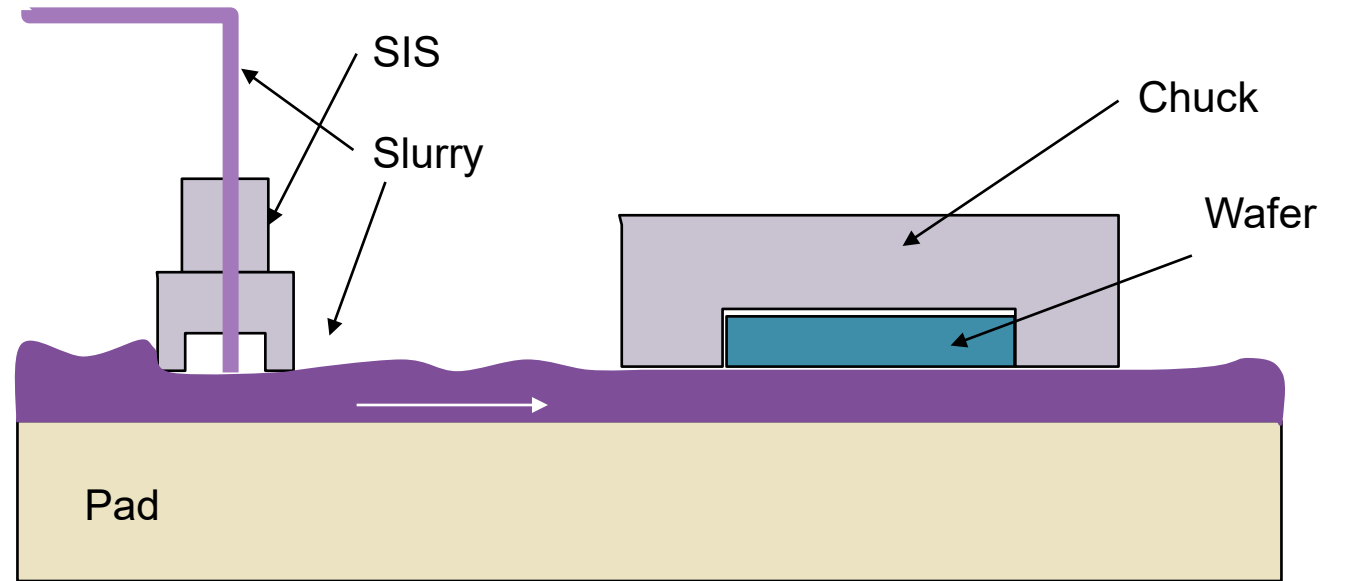


Slurry splash

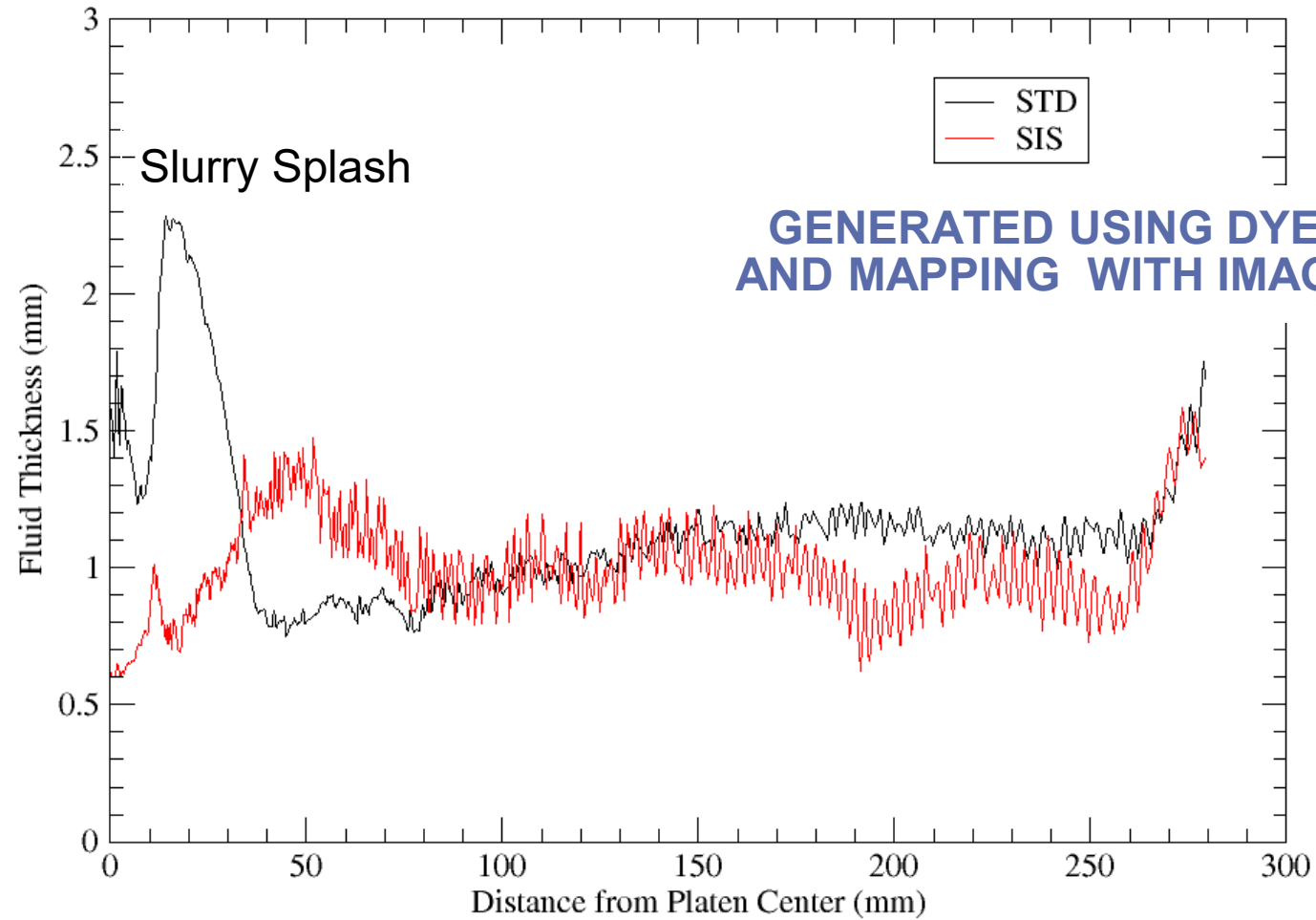


SIS PROCESS

- **Smoother and More Uniform Slurry Distribution**
- **Used (and Dirty) Slurry is Prevented from Re-Entry into the Pad-Wafer Interface**



SLURRY DISTRIBUTION CONSISTENCY



FLAT FILM METRICS

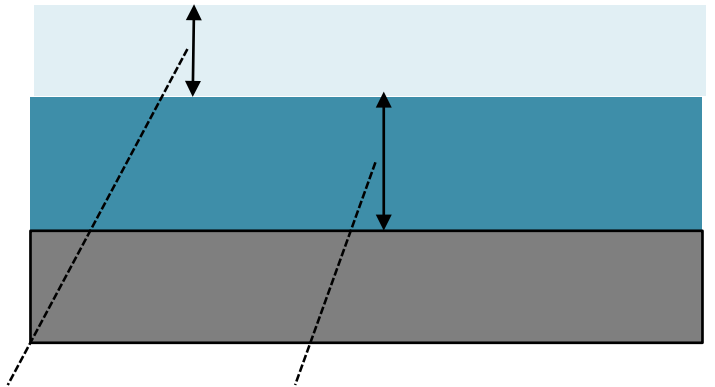
- **Post-CMP Non-Uniformity vs Polish Rate**
- **Polish Non-Uniformity vs. Polish Rate**
- **Polish Rate Consistency**
- **Slurry Usage Reduction**

Pre-CMP Monitor Cross-Section



Polish Non-Uniformity
 $P_{nu} = (STD) / (Avg \text{ Polished Amount})$

Post-CMP Monitor Cross-Section



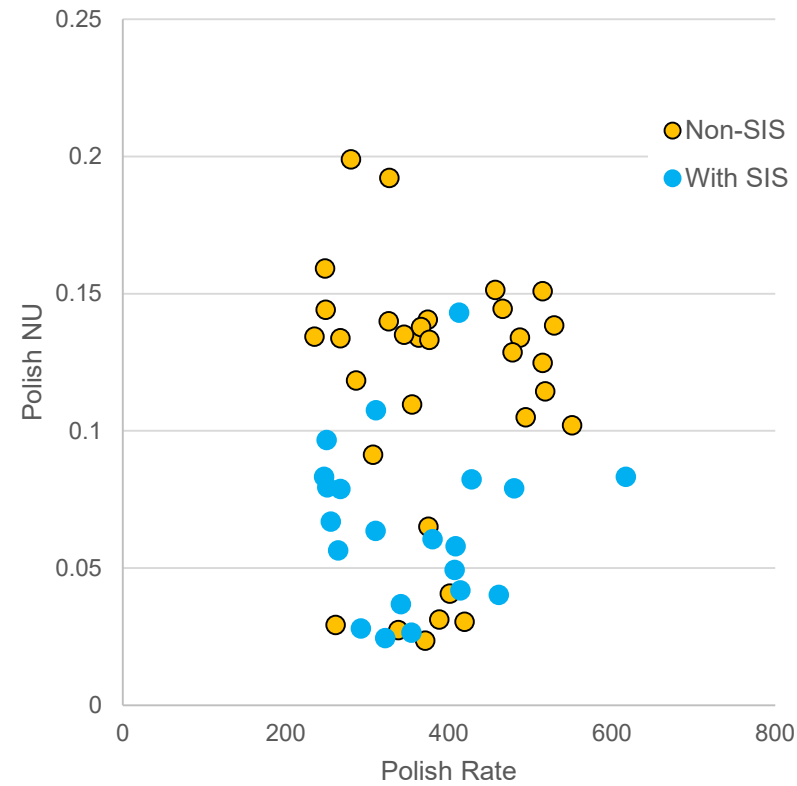
Post-CMP Non-Uniformity
 $NU = (STD) / (Avg \text{ Remaining Amount})$

SIS PROCESS ON SiO2 FILM

SiO2 Post-CMP NU



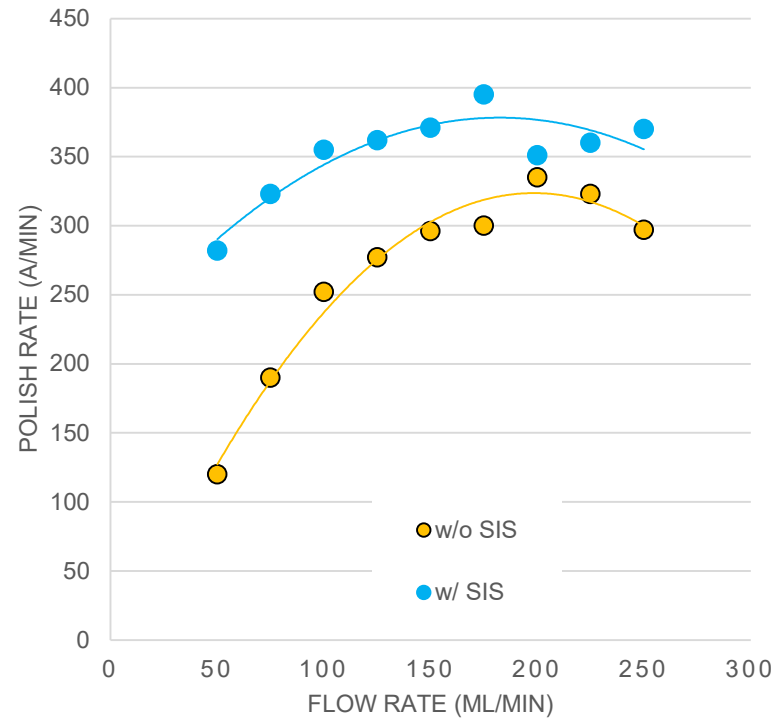
SiO2 Polish NU



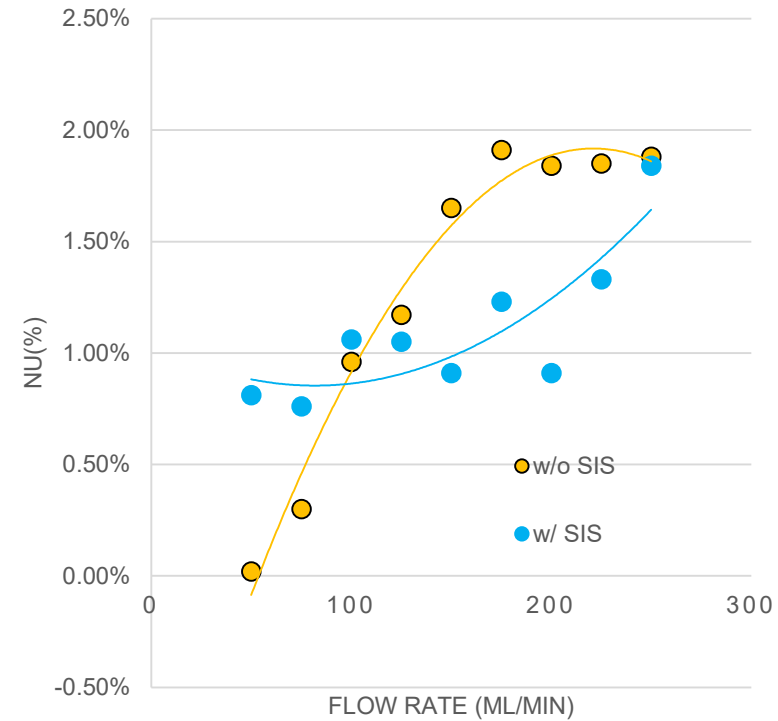
Metric	Standard Process	SIS Process
Polish Rate Average	313	310
Polish Rate STD	96	84
Post-CMP NU	1.85%	1.47%
Polish NU	11.39%	6.60%

SiO2 SLURRY SAVINGS WITH THE SIS

SiO2 Polish Rate



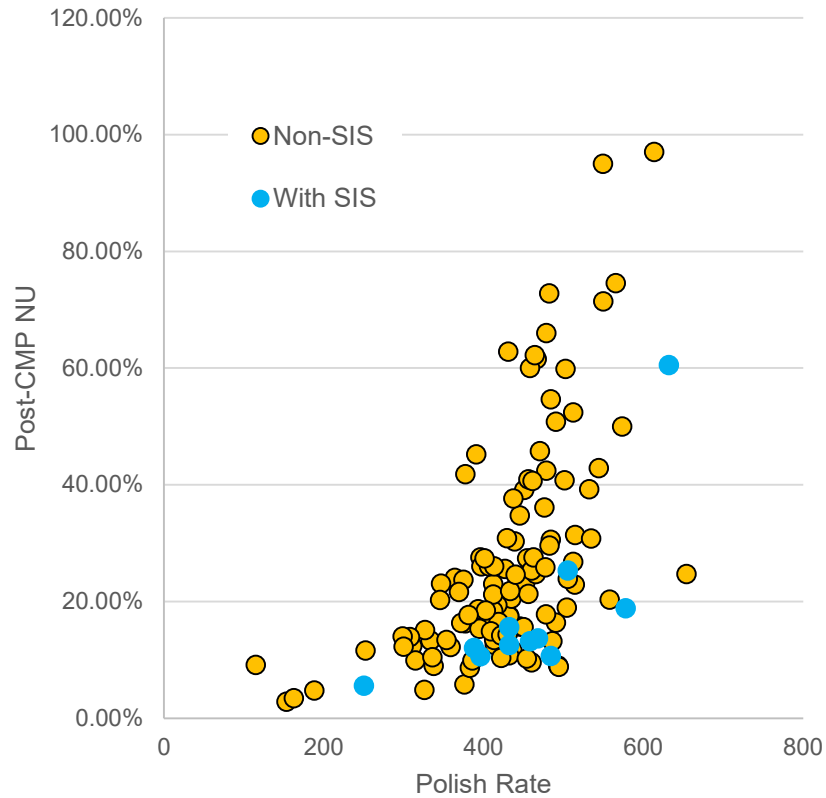
SiO2 Post-CMP Non-Uniformity



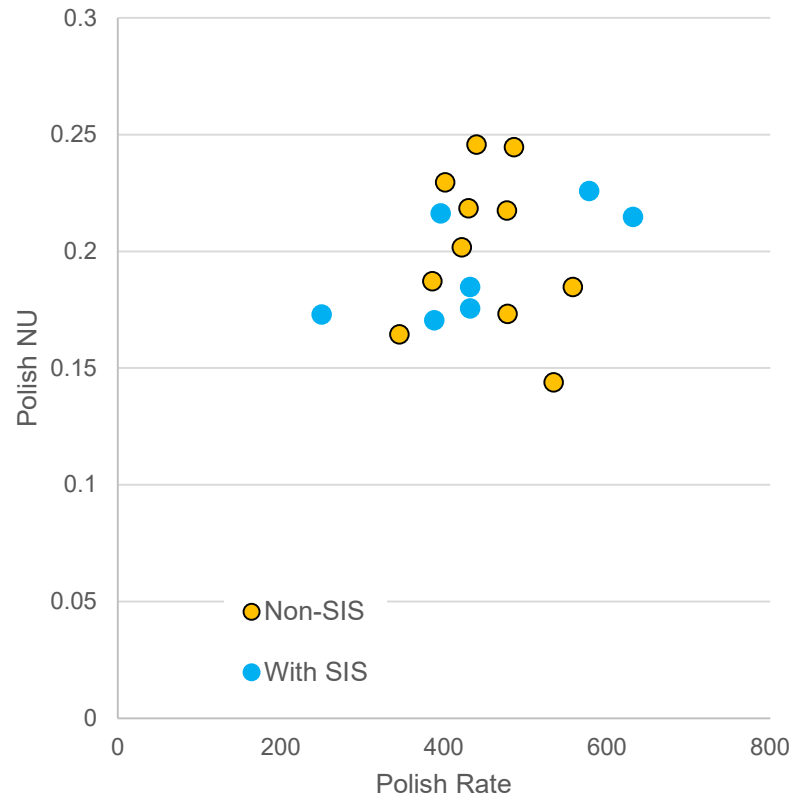
SIS recipe flow rate <100 mL/min
Standard Non-SIS flow rate = 250mL/min

SIS PROCESS ON METAL A FLAT FILM

Metal A Post-CMP NU

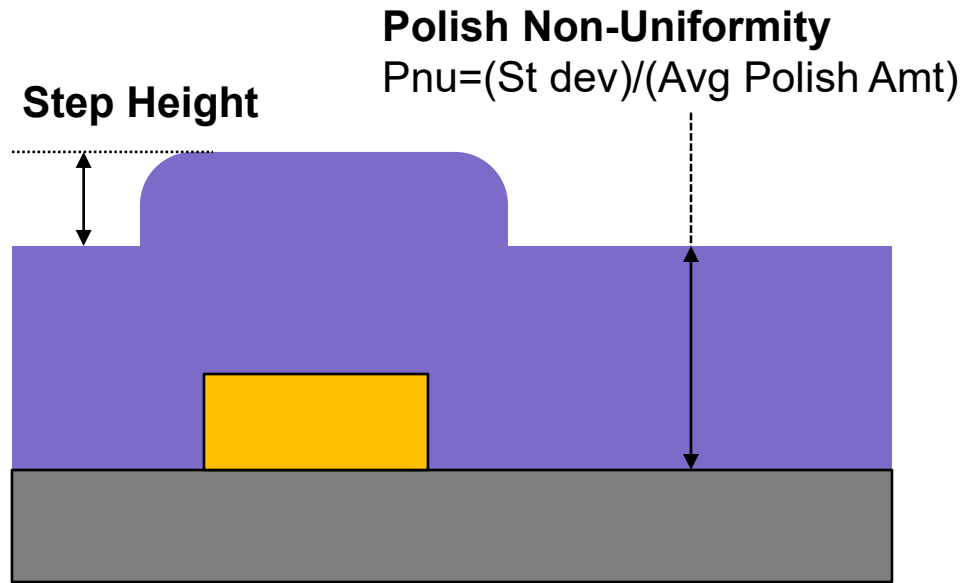


Metal A Polish NU

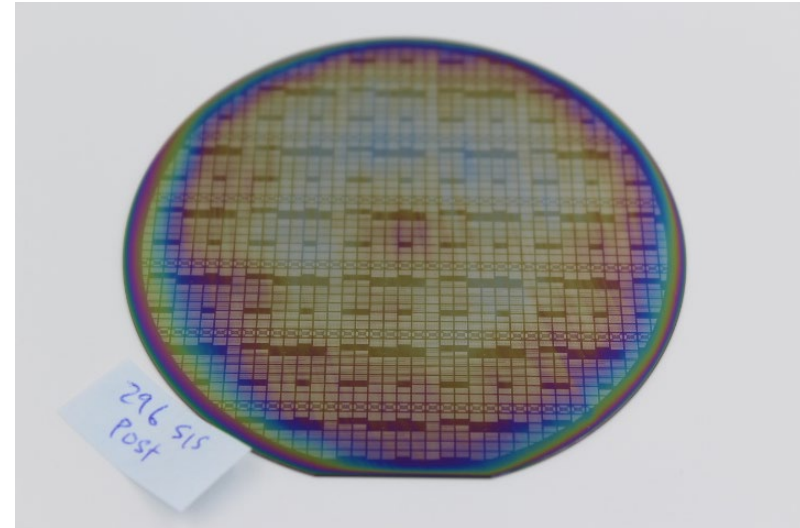


Metric	Standard Process	SIS Process
Polish Rate Average	420	457
Polish Rate STD	94	101
Post-CMP NU	26.12%	18.06%
Polish NU	27.69%	19.44%

SUBSTRATE USED IN PATTERNED WAFER ANALYSIS

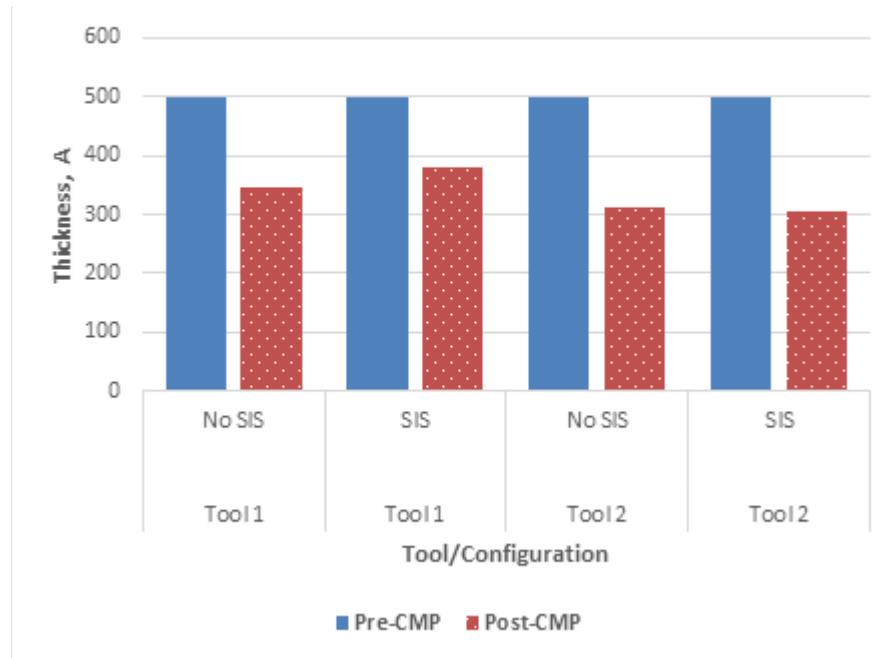


SiO₂/Ti(AI)/Si SUBSTRATE

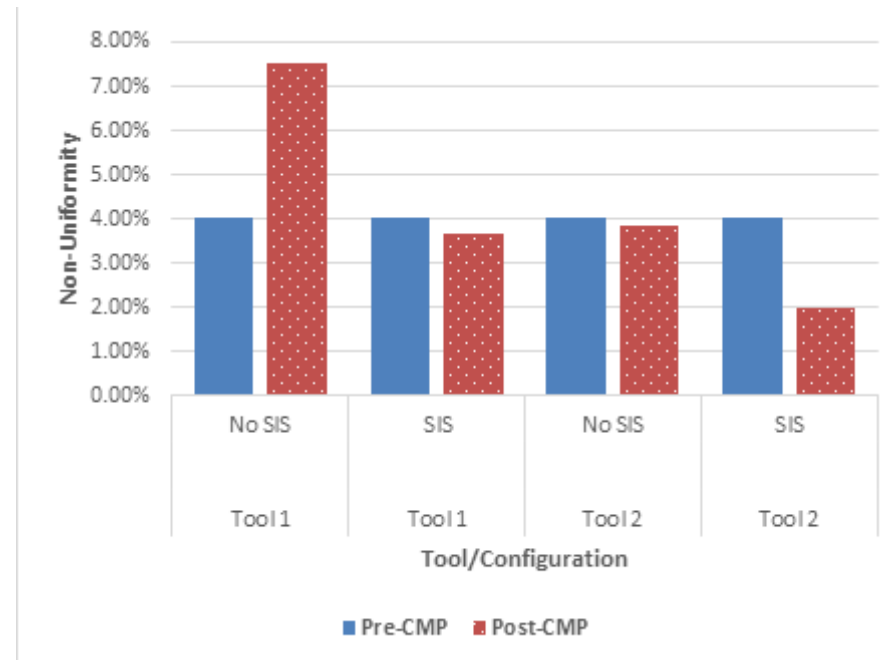


STEP HEIGHT AND NU – SIS VS. STANDARD

Step Height Comparison



Step Height Non-Uniformity Comparison



STEP HEIGHT AND NU COMPARISON ON SiO₂/Ti(AI)/Si PATTERNED WAFERS RUN ON 2 TOOLS – SIS RESULTS IN IMPROVED NU COMPARED TO STANDARD CONFIGURATION

CONCLUSIONS

- The absolute metrics of monitor wafers thus far support the thesis that the **SIS makes positive improvements on the polishing tool for oxide and metal processes.**
- The absolute metrics of patterned wafers **provide positive results as far as step height and non-uniformity with regards to SIS versus non SIS.**
- Above all, we show slurry consumption is reduced by **more than 50%** using SIS versus standard tool configuration for both the metal and oxide processes significantly reducing the cost of ownership of the CMP process.

ACKNOWLEDGMENTS

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Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors.