Cabot Microelectronics Corporation

Consumable Technologies to Cover a Wide Variety of CMP Applications

US CMPUG, 9 April 2008
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Perfecting the Surfaces of Tomorrow™

Cabot Microelectronics

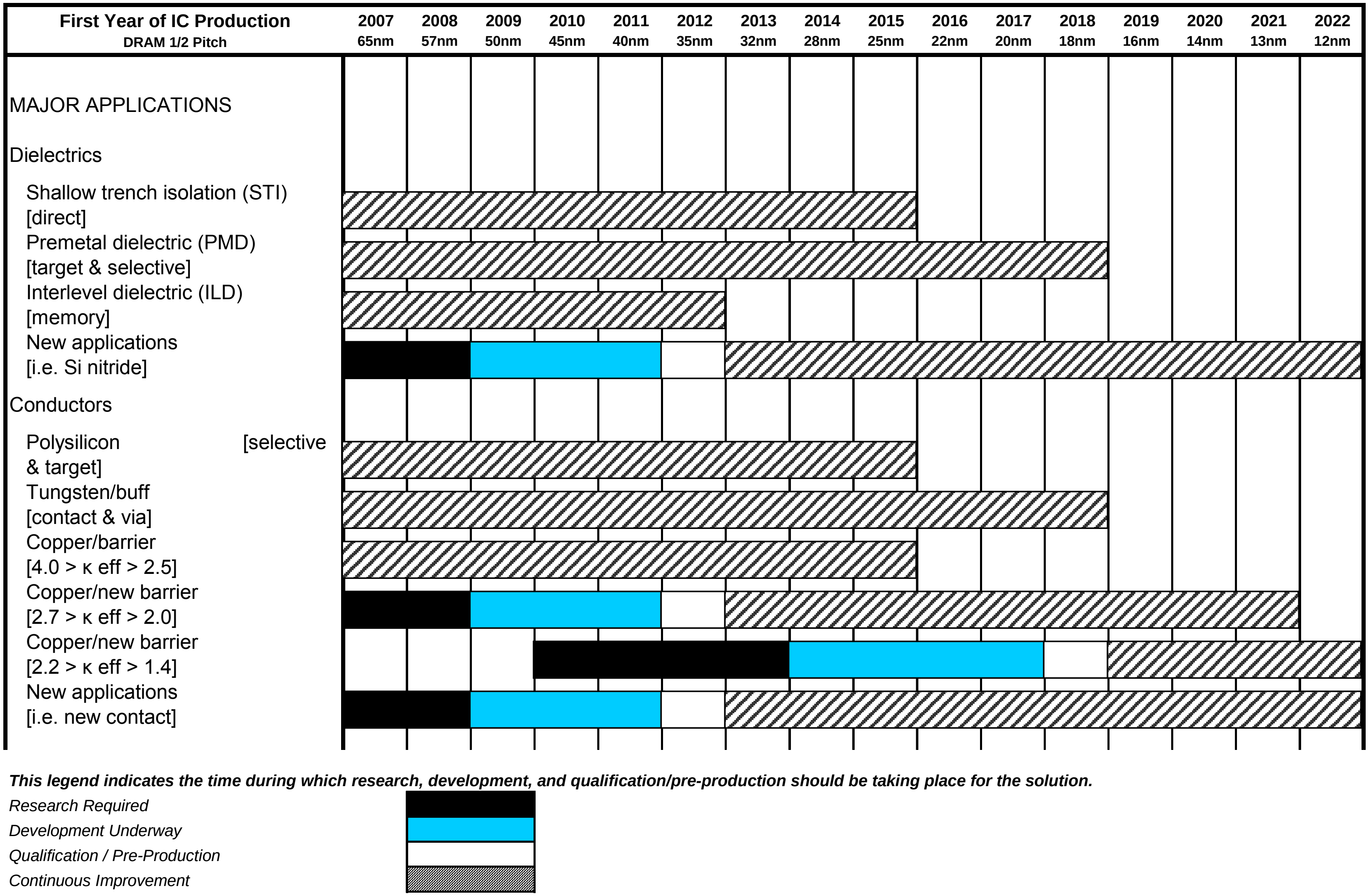
Outline

- Need for new IC CMP applications
- Existing applications
  - Tungsten, Dielectric, Copper, Barrier
- New applications
  - Emerging IC applications
  - Extension beyond IC's
- Summary

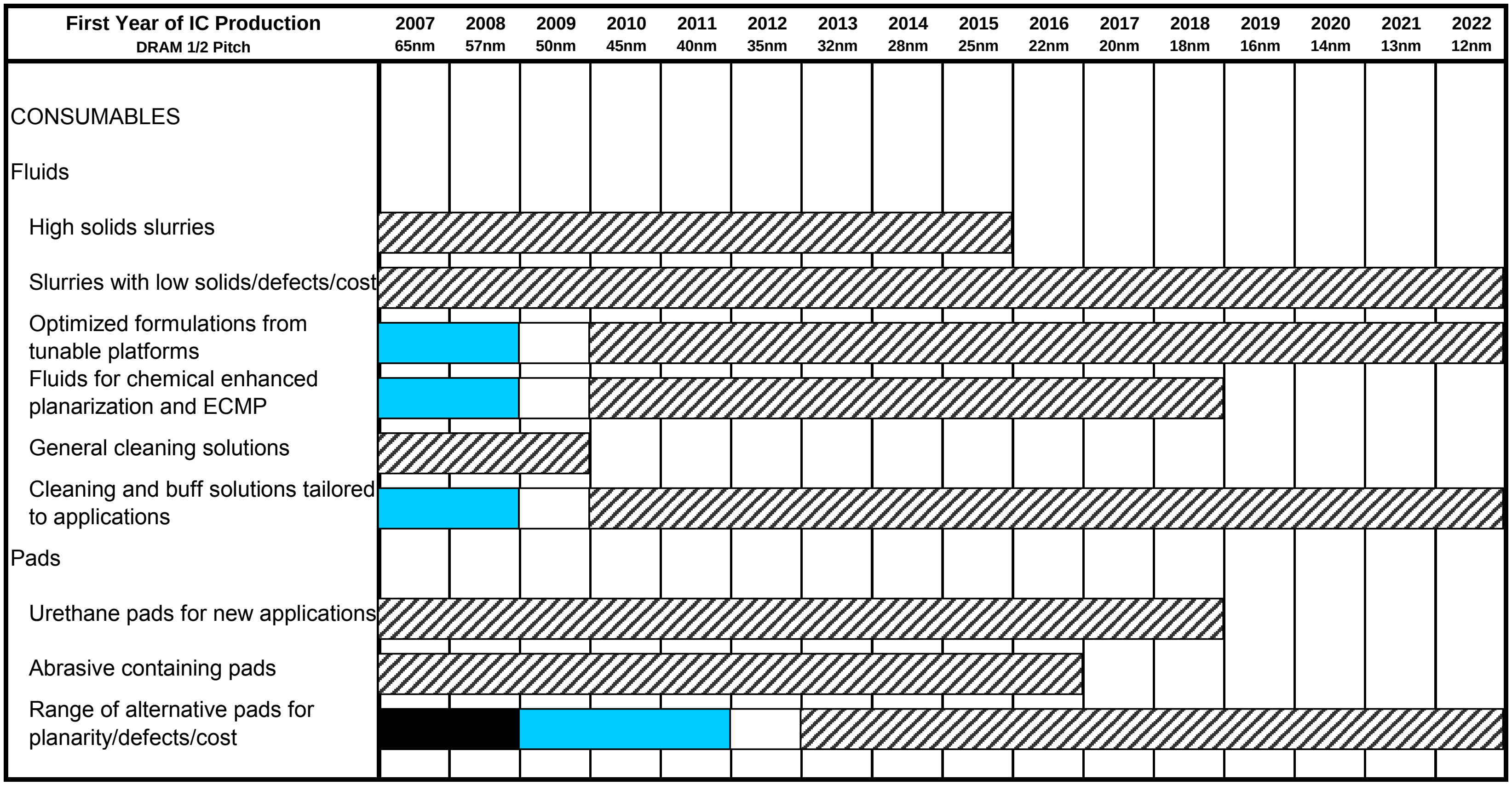
Why Do We Need New CMP Applications?

- New CMP applications arise when continuous improvement of consumables and equipment are not sufficient
- New applications are driven by smaller dimensions
  - Requirements for a given CMP process get tougher
    - Step function in performance needed
    - Need to optimize away from general purpose consumables
  - IC integration changes with each new advanced node
    - New and more complex structures drive new combinations of existing materials
    - Increased complexity leads to segmentation of requirements
    - New materials required to get chip performance and yield
  - Benefits of CMP spilled over into DRAM and NVRAM/flash
    - Accelerated by performance requirements and falling CMP CoO

ITRS 2007 Planarization Applications



ITRS 2007 Planarization Consumables



This legend indicates the time during which research, development, and qualification/pre-production should be taking place for the solution.

Research Required
Development Underway
Qualification / Pre-Production
Continuous Improvement

Core Product Pipeline
Advanced Solutions Across Applications

Product Evolution

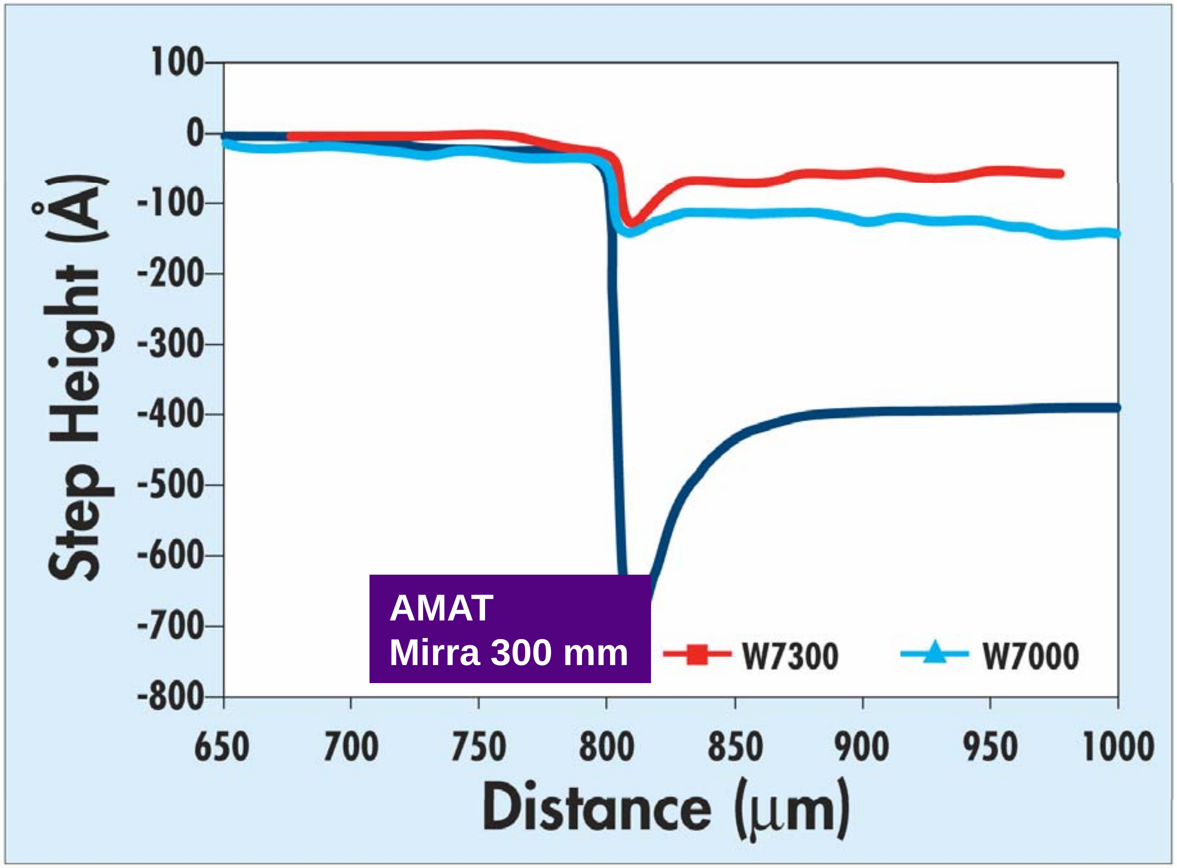
Tungsten	Advanced Dielectric / ILD	Copper	Barrier	CMP Pads	Emerging Materials
W2000 Series	**Semi-Sperse Series**	**C5000 Series**	**B5200 Series**	**D100**	**Aluminum**
W6000 Series	**D1300 Series**	**C6000 Series**	**B6618**		**Ruthenium**
W7000 Series	**D3500/D4500 Series**	**C7000 Series**	**B7000 Series**		**Nitride**
	D6700 Series	**C8000 Series**	**B8500 Series**		**Dielectric**
	D8100 Series				**Poly**
					Noble Metals
					Metal Gates
WIN	iDIEL Semi-Sperse	i-Cue	i-Cue	Epic	

Tungsten Solutions *for Advanced Technologies*

	Selective Approach W7000	Tunable Selectivity Approach W7300
Customer Requirements	High Selective Solution for Advanced Technologies	Tunable Selectivity for Advanced Technologies
Formulation	Fumed Silica and Etch Inhibitors	Colloidal Silica and Etch Inhibitors, Compatible with All Other CMC W Products
Performance	W:Ox (200:1) Erosion < 200Å Defectivity = < 0.25X	W:Ox (Tunable) Erosion < 200Å Defectivity = < 0.25X
Manufacturing Status	Commercial in Japan	Commercial in Japan

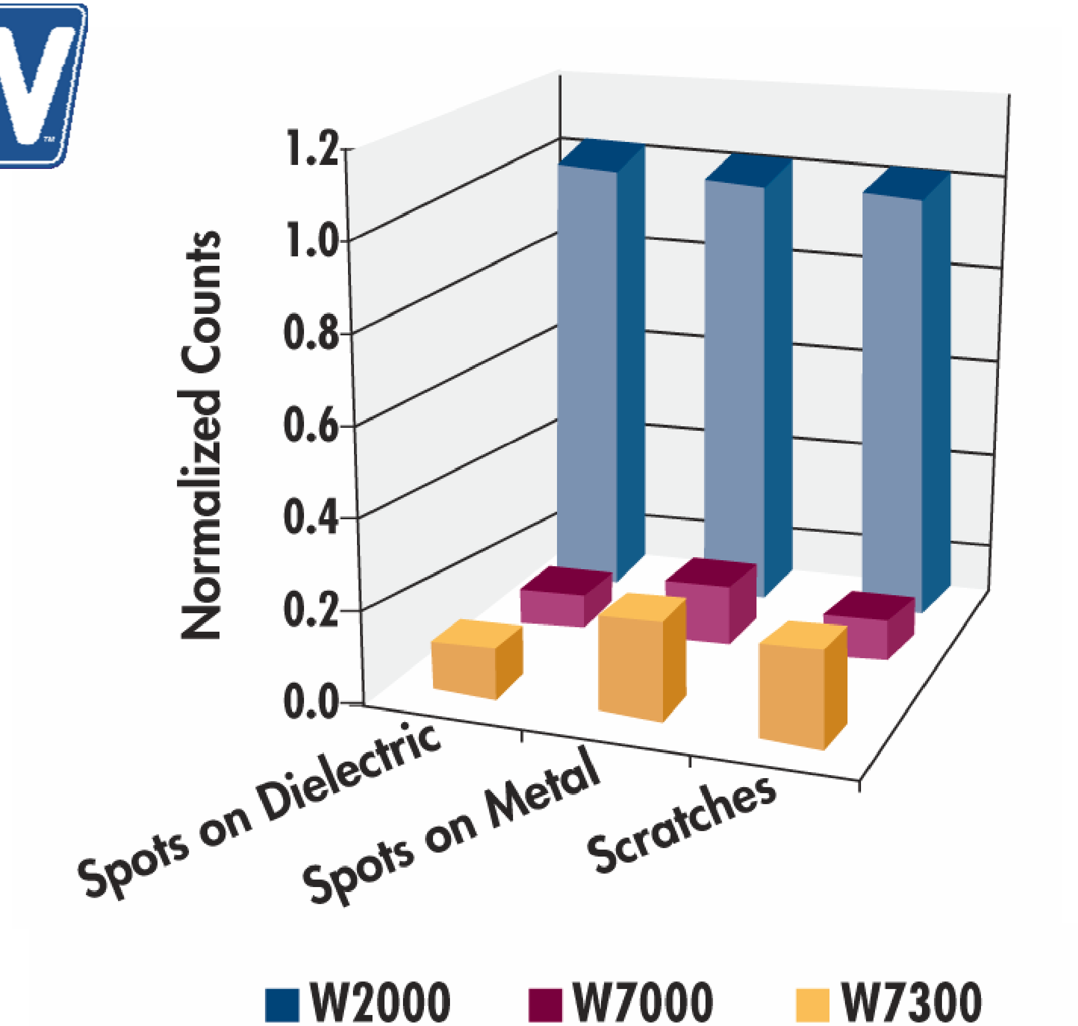
X = Benchmark W2000

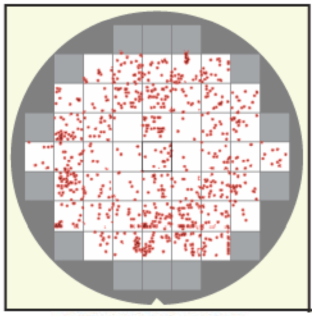
Edge-Over-Erosion (EOE) Performance



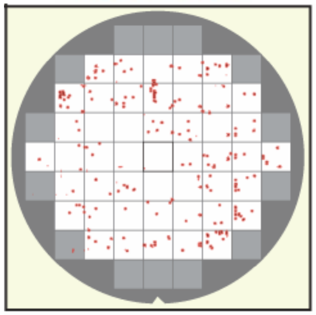
EOE is significantly reduced / eliminated with our advanced WIN™ products

Best-in-Class Defect Performance

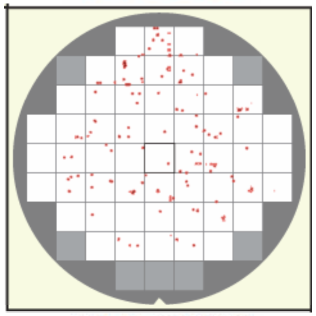




W2000

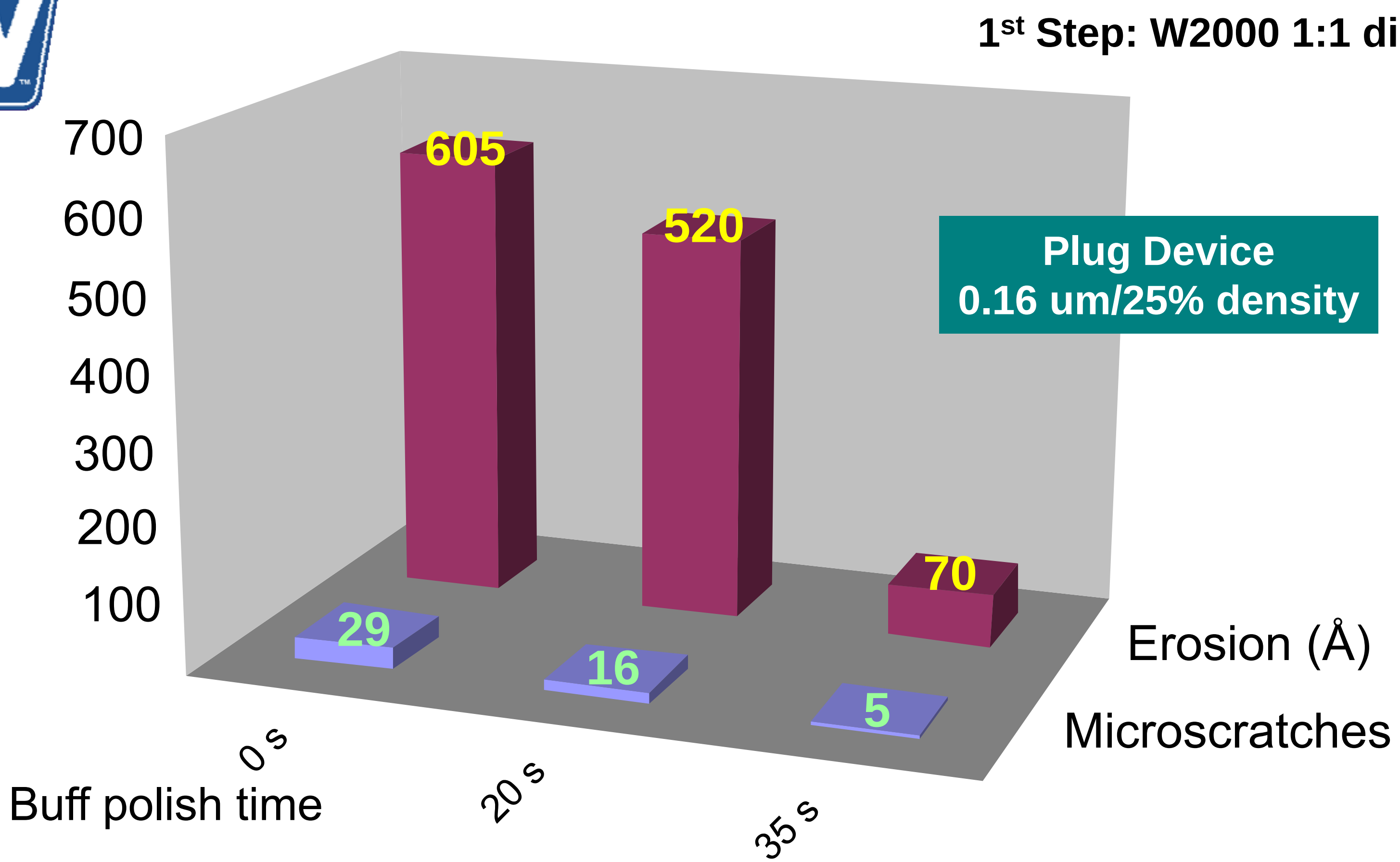


W7300



W7000

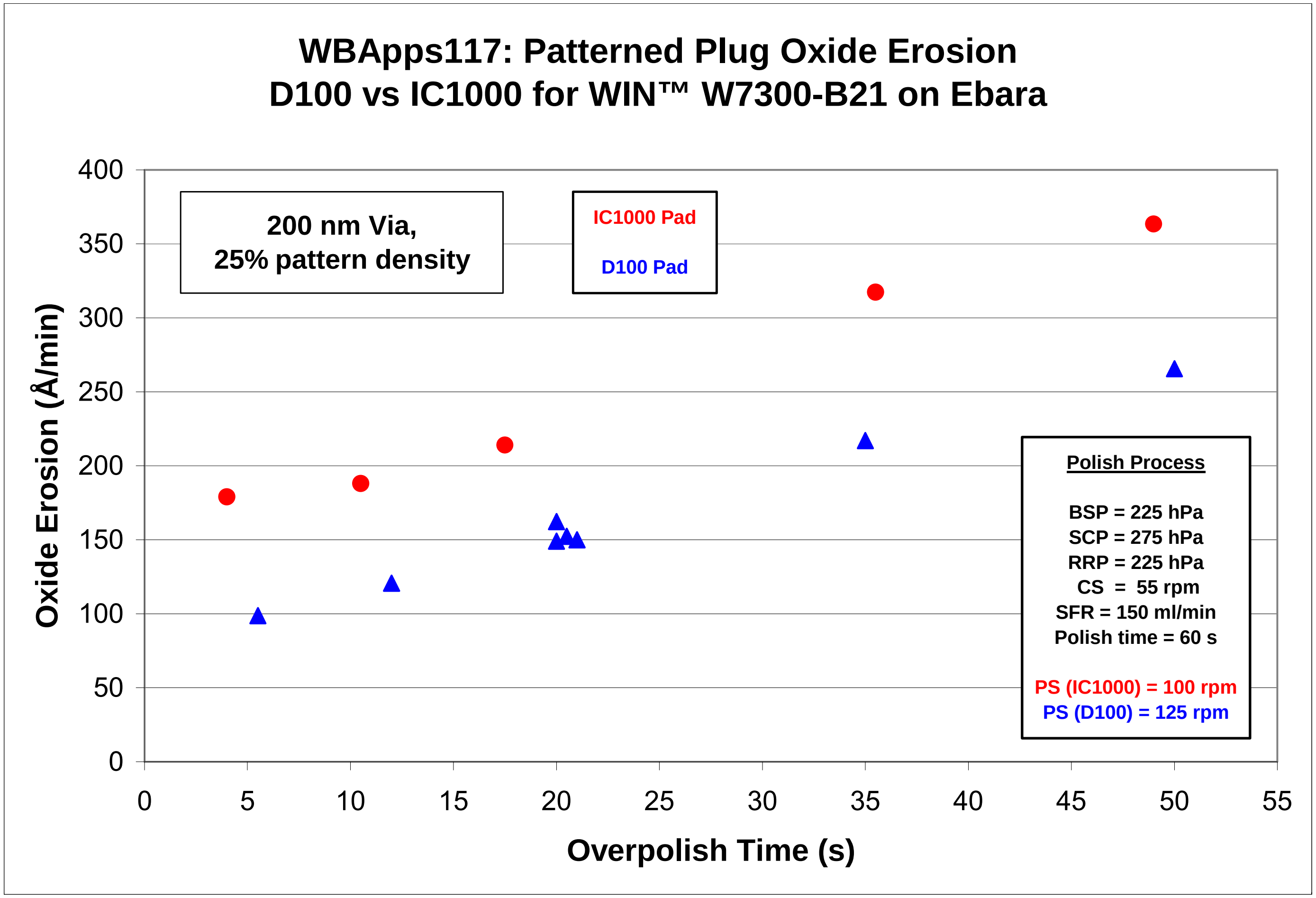
W7300 Best-in-Class Performance *Buff Step*



Significant reduction in both defectivity and erosion after W7300 buff step

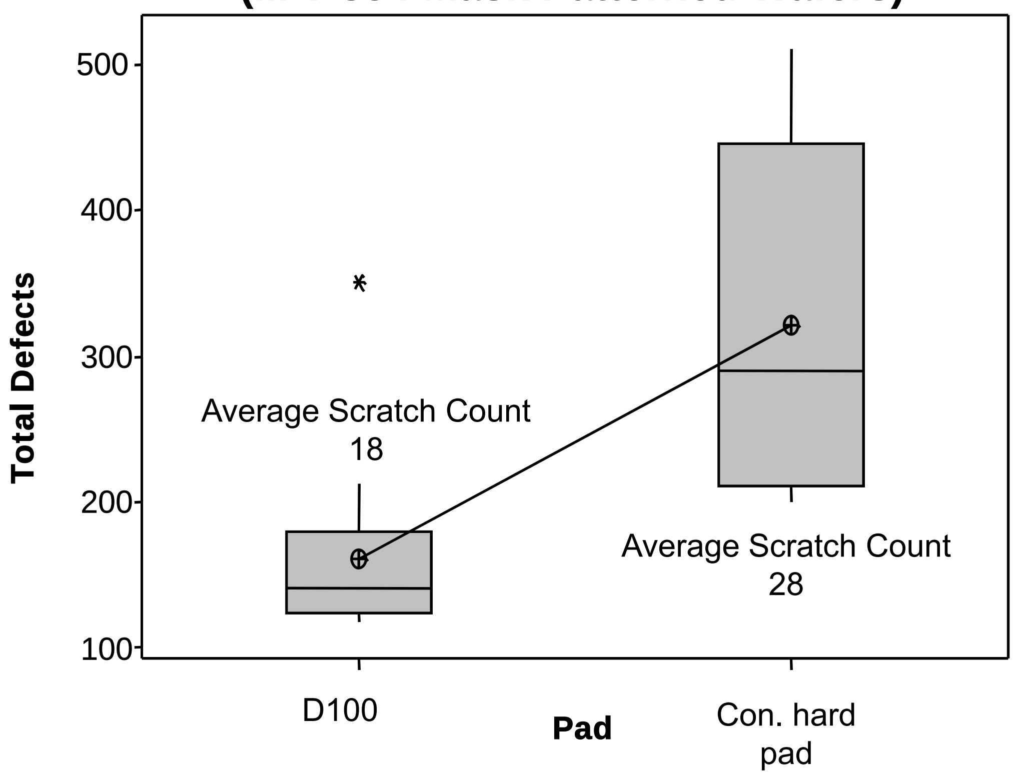
WIN™ W7300 B21 / Epic® D100 Combo

Erosion Performance – Mirra 200mm



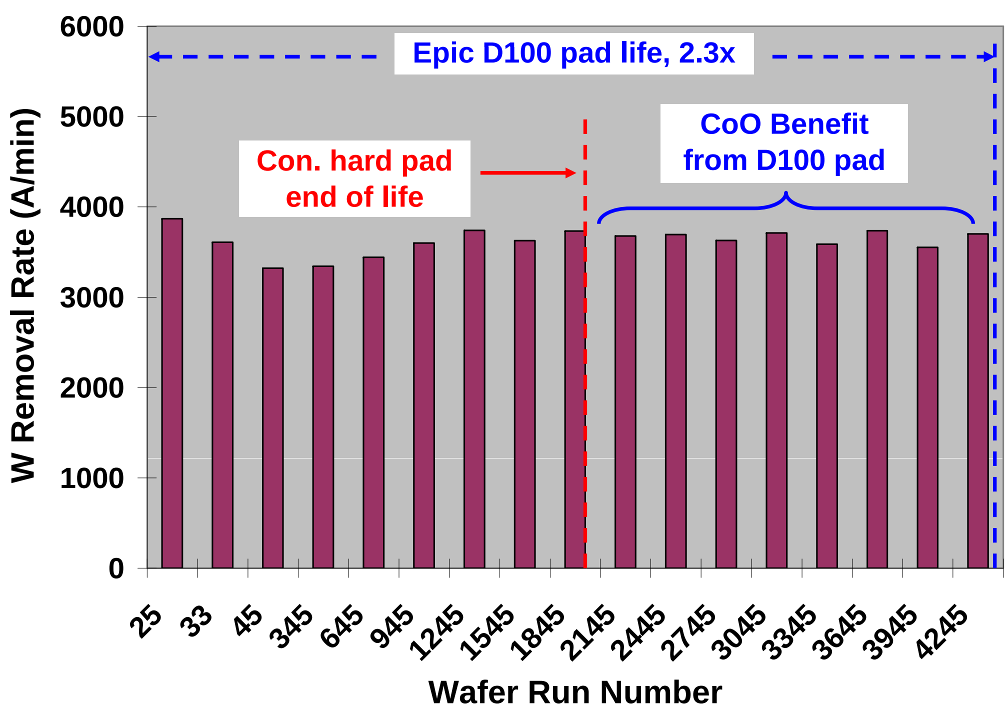
D100 Improved Defectivity

Defect and Scratch Counts
(MIT 854 Mask Patterned Wafers)



> 35% defectivity reduction by using D100 pads

Epic D100 Longer Pad Life



** 15 mils groove depth

- **Longer pad life confirmed in high volume manufacturing**
  - 2.5x conventional hard pad
  - 4x polyurethane impregnated polyester pad
- **Improved CoO for Customers**

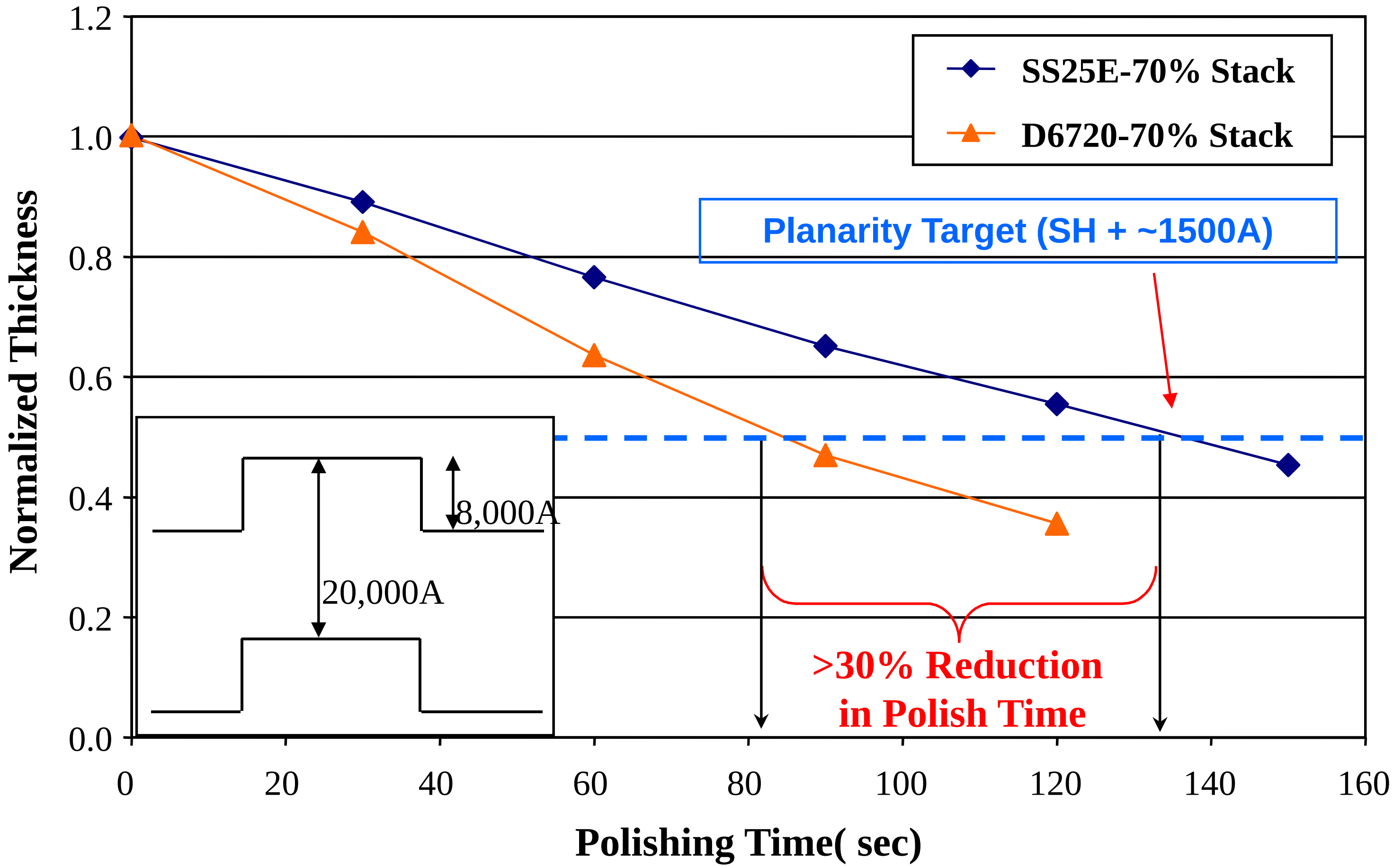
iDIEL™ D6720

and Extension to STI Applications

	D6720	D6720-B10
Abrasive Type	Hydrothermal Ceria	none
Chemistry	pH ~ 5.1 High Purity (no KOH) Rate Control Additive	Self-Stopping Additive (SSA)
Mechanism	Balanced Chemical & Mechanical high Ox/SiN selectivity	Self-Stopping When Added to C2
Mean Particle Size	~ 90 nm	none
Particle Concentration (POU)	< 1.0%	none
Method of Use	2X Concentrated POU or In-line mixing with B10 or by itself	POU Mixing With D6720

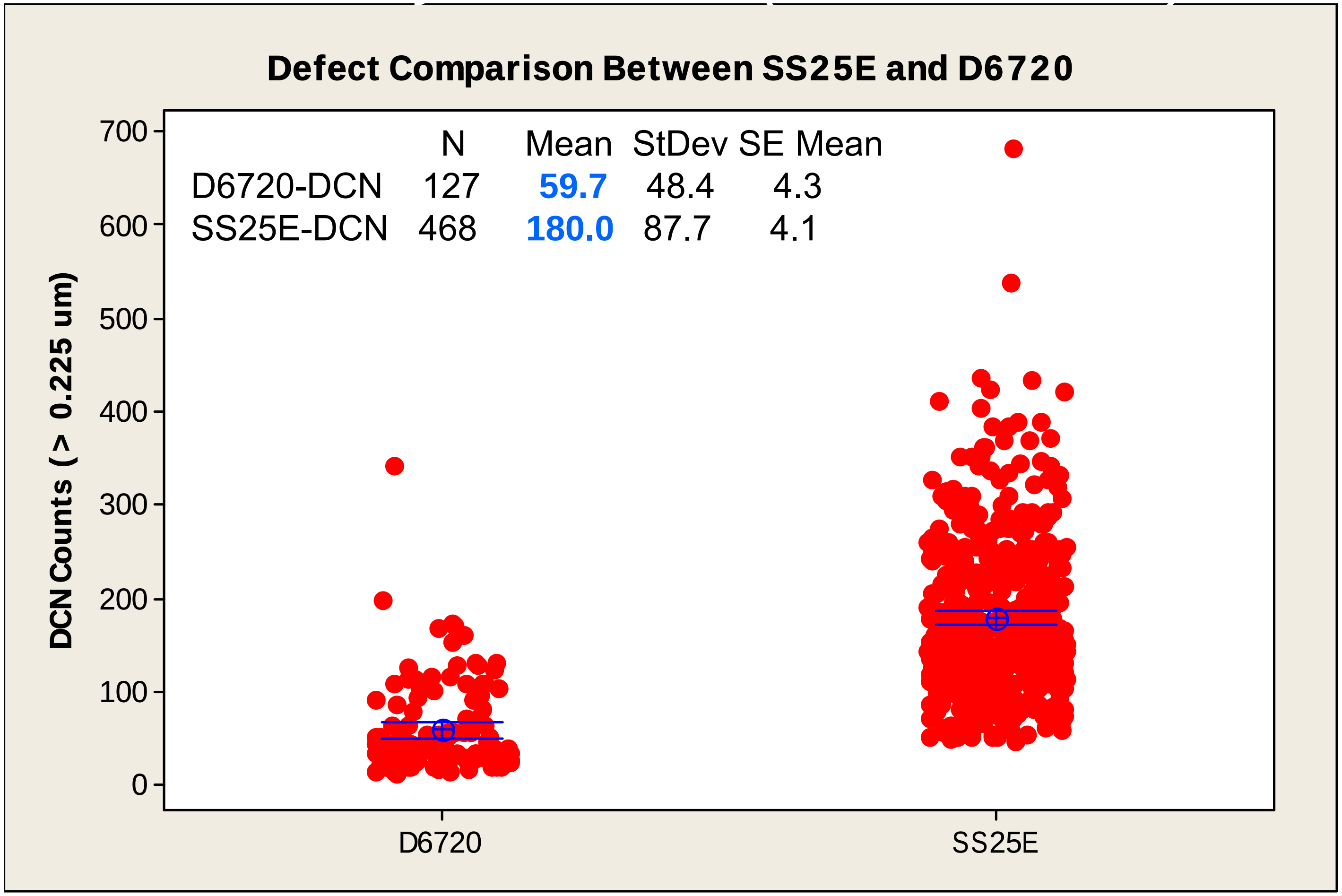
iDIEL™ D6720

Dielectric Removal on ILD Pattern



D6720 planarizes faster compared to SS25E (polishing time can be shorter)

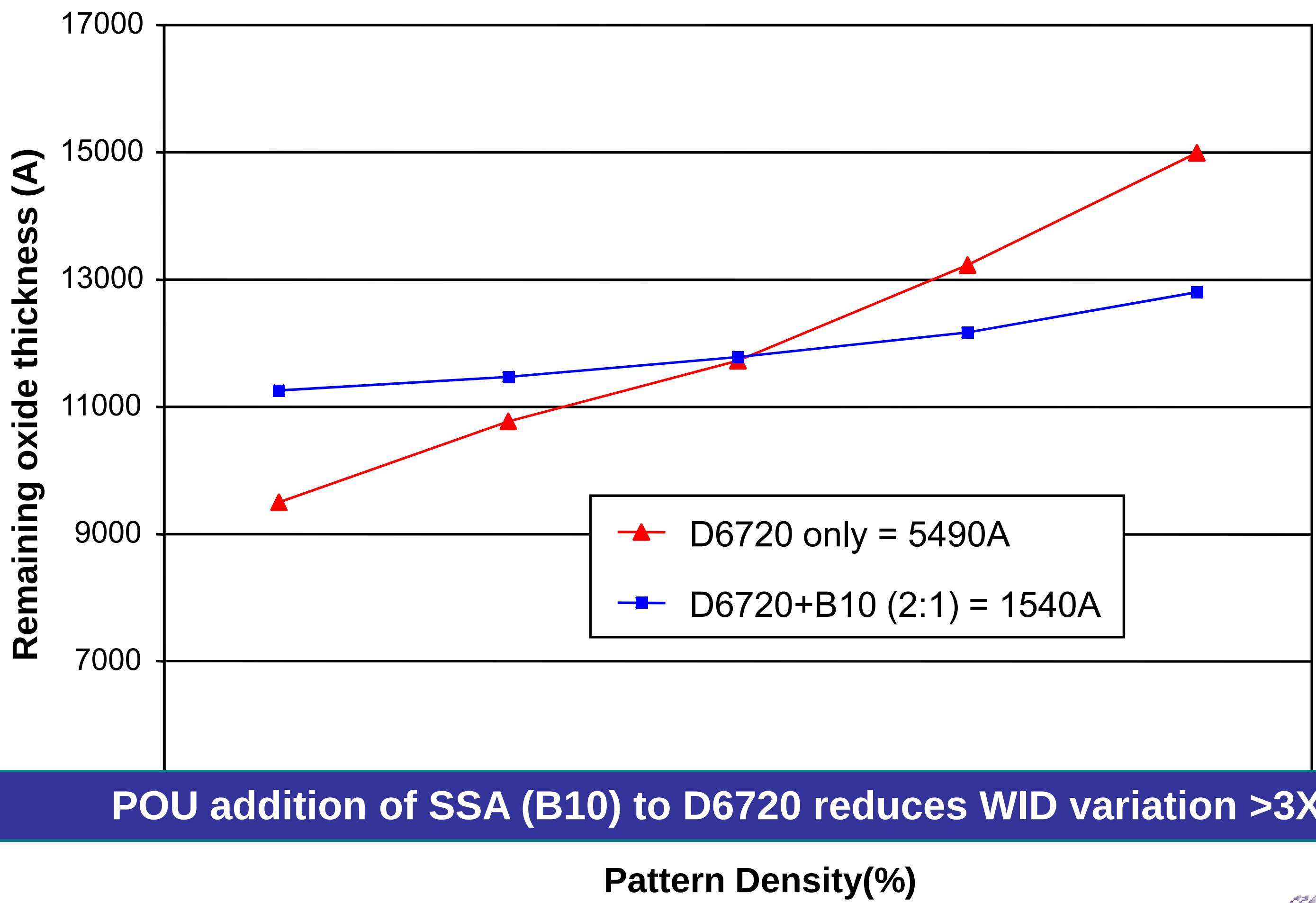
iDIEL™ D6720



D6720 shows 3X reduction in defectivity compared to SS25E

iDIEL™ D6720

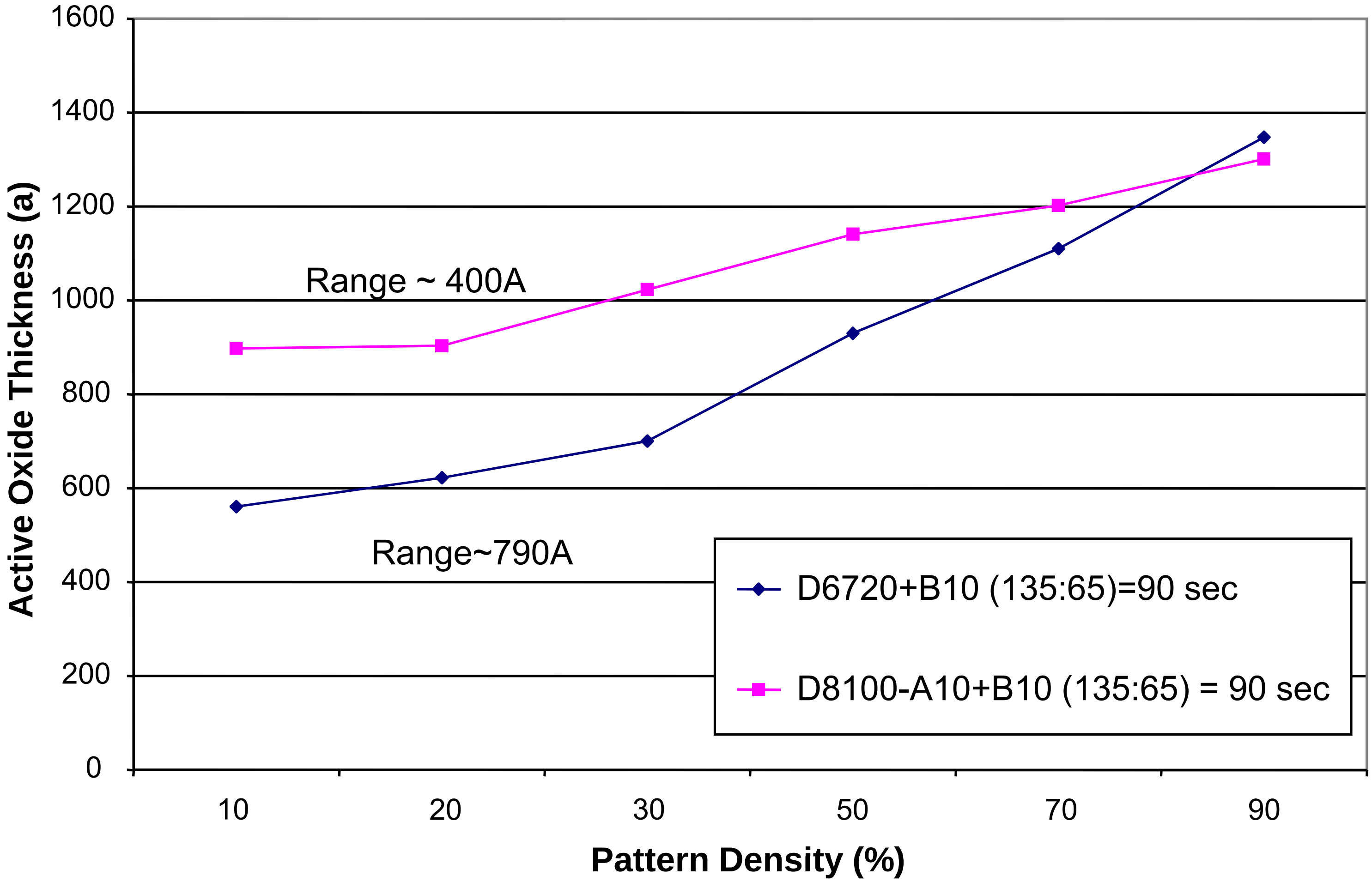
POU Mixing of SSA - ILD Test Pattern



POU addition of SSA (B10) to D6720 reduces WID variation >3X

iDIEL™ D8100 vs. iDIEL D6720

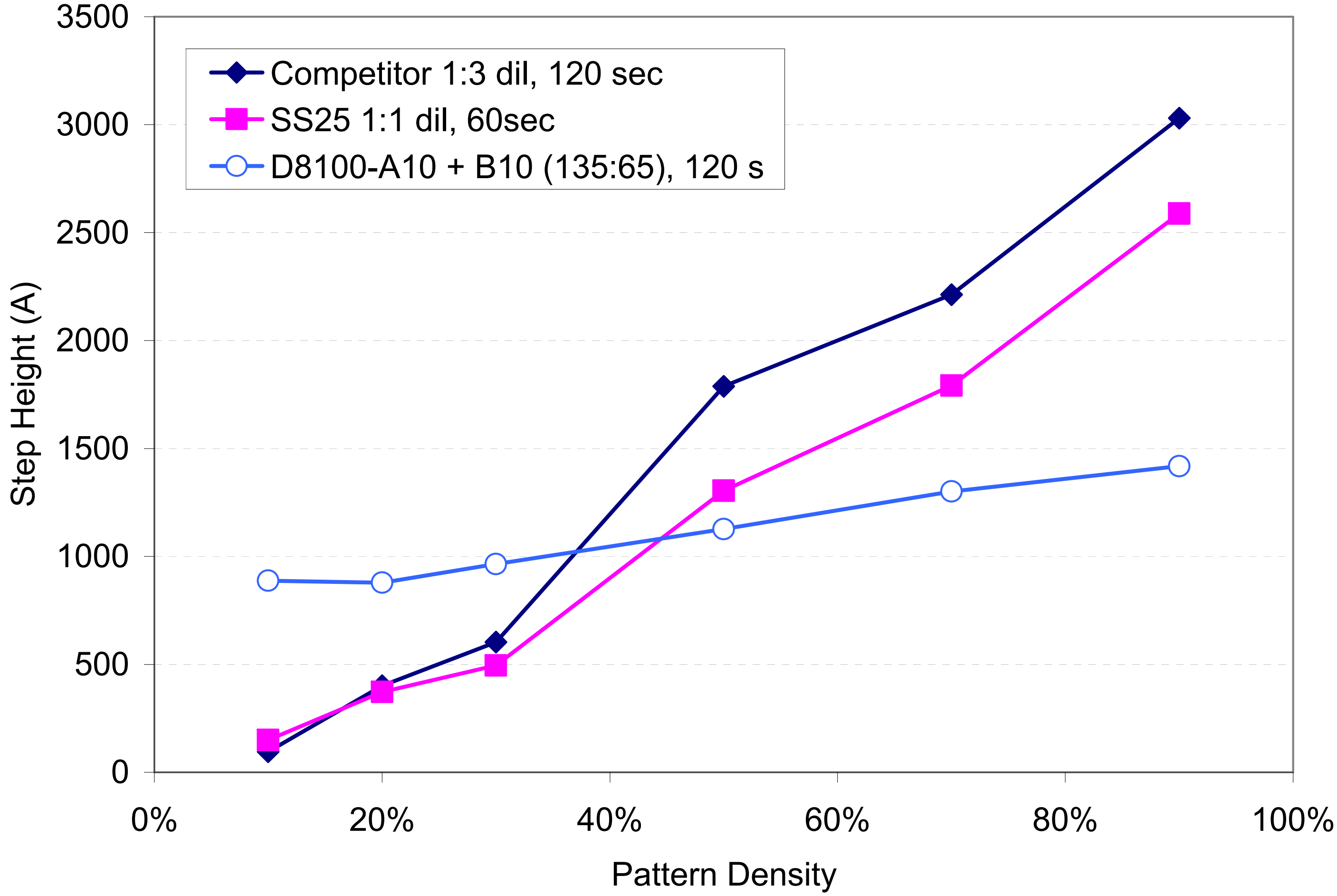
POU Mixing of SSA - STI Test Pattern (Logic)



D8100 is better than D6720 for planarity on STI test pattern

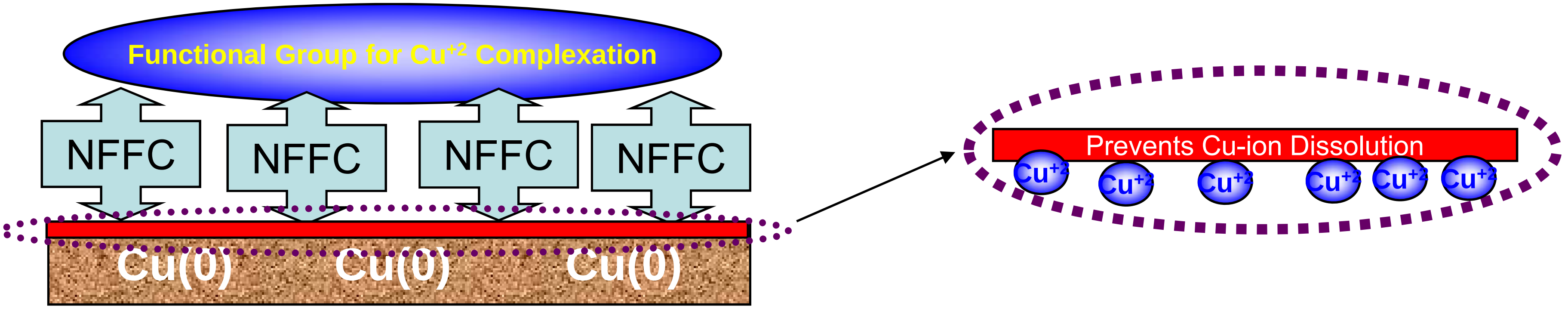
iDIEL™ D8100 vs. Competition

STI Test Pattern (Logic)

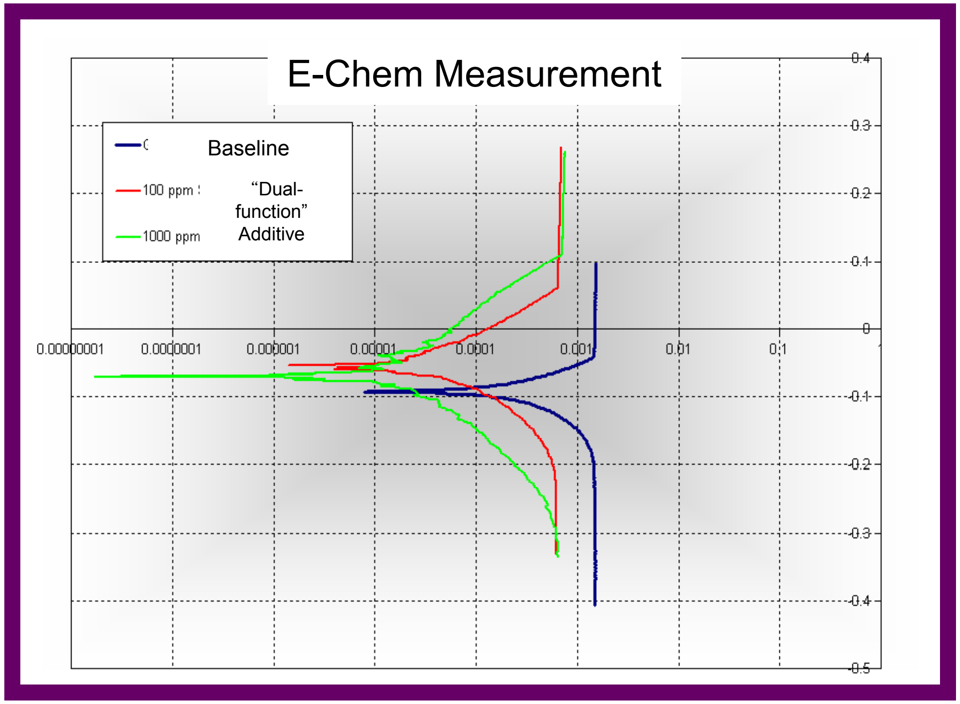


D8100 is better than competitor slurry for planarity on STI test pattern

Formulation Design for C8100



- pH buffered near neutral to balance oxidation/dissolution mechanisms
- Addition of "dual functional" additive for Cu surface passivation



NFFC = "Novel Film Formation Chemistry"

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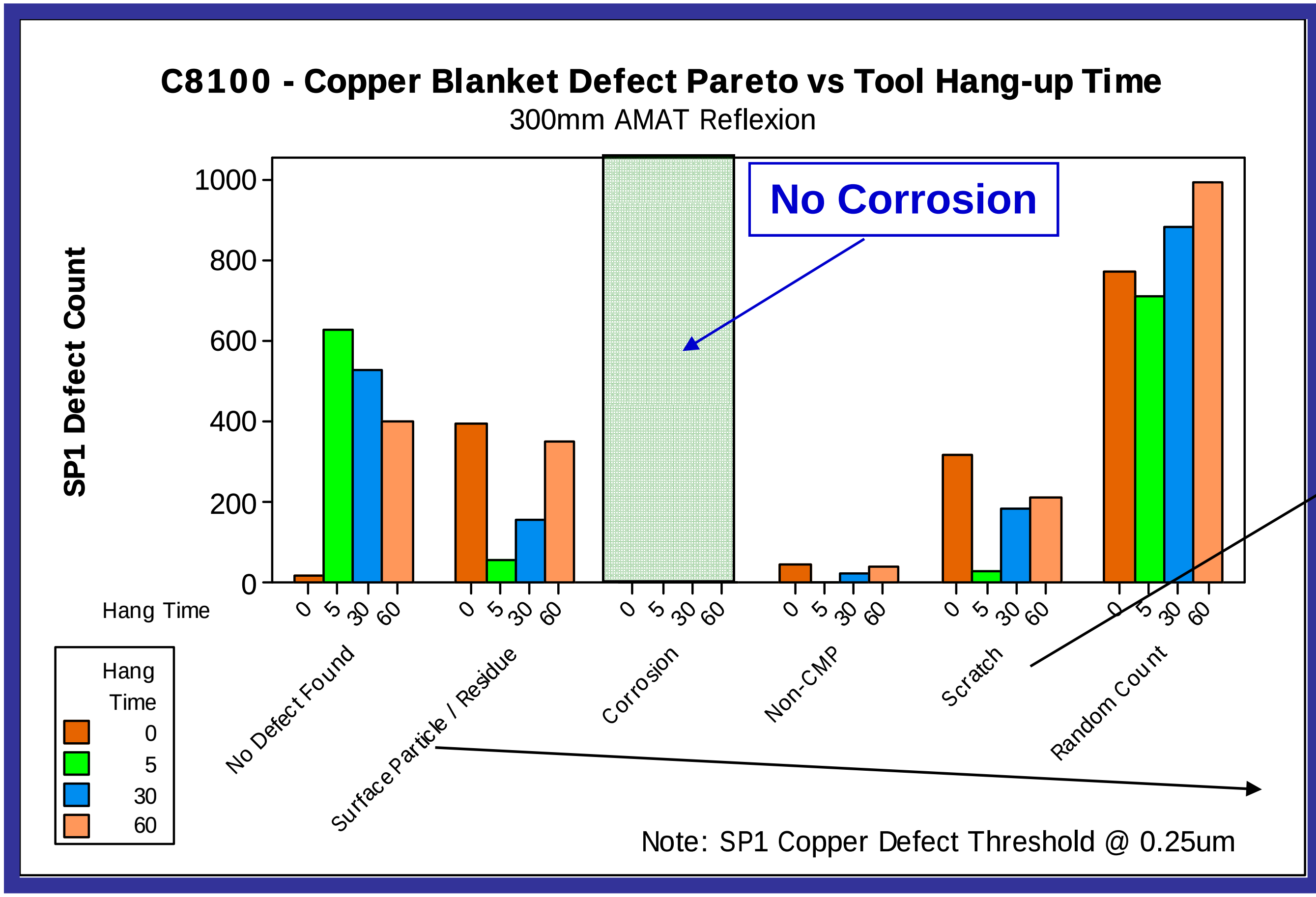
Next Generation Copper Slurry - iCue® C8100

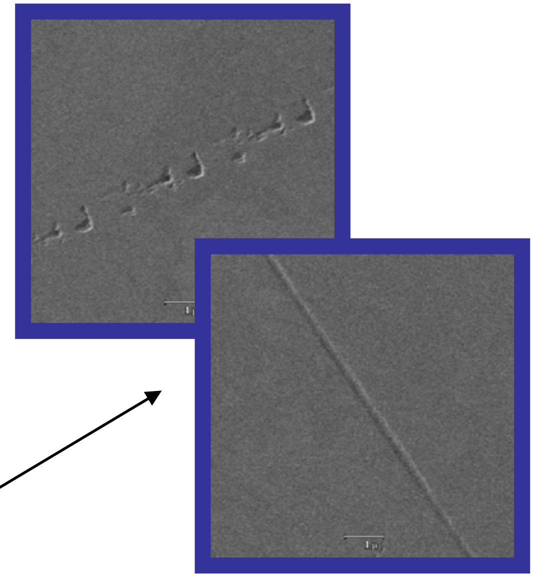
Characteristic	C8100
Dilution Ratio	5X – 10X
pH (at POU)	6
Particle	Nano-Colloidal Silica
Particle % (at POU)	0.5 – 1.0%
Peroxide Addition	1%

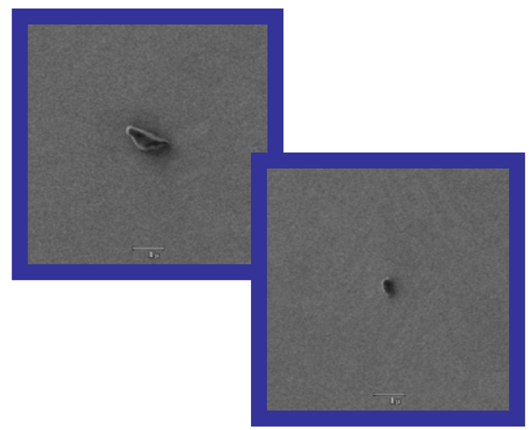
C8100 Selectivity

Downforce (psi)	Copper Removal Rate (Ang/min)	Tantalum Removal Rate (Ang/min)
0.5	2420	0
1.0	4360	0

Polishing Tool Fault Simulation – iCue® C8100







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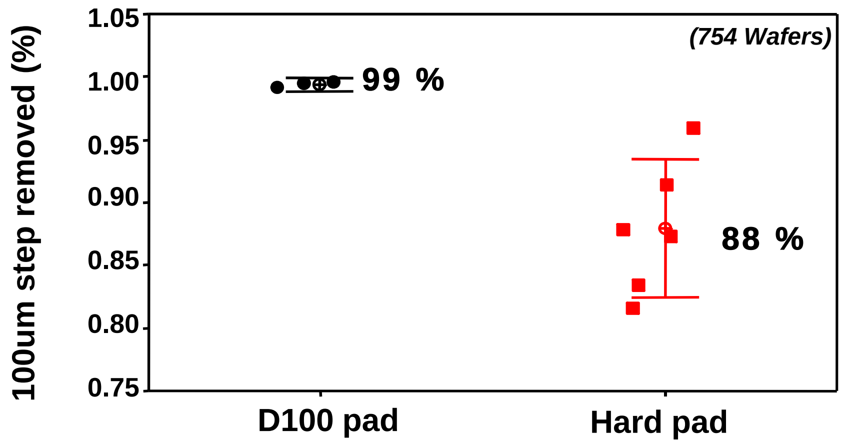
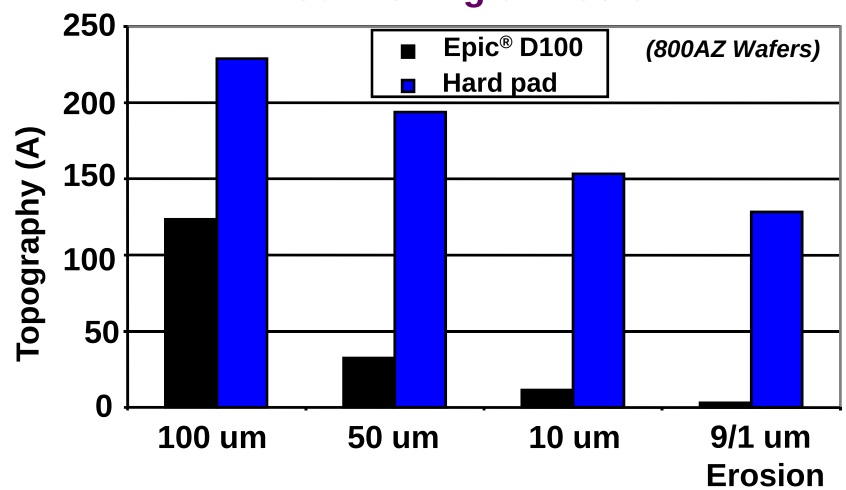
Epic D100 Enhanced Planarity

- **Copper Planarity**
  - D100 dramatically enhances bulk Cu planarization efficiency
  - D100 delivers improved dishing and erosion performance

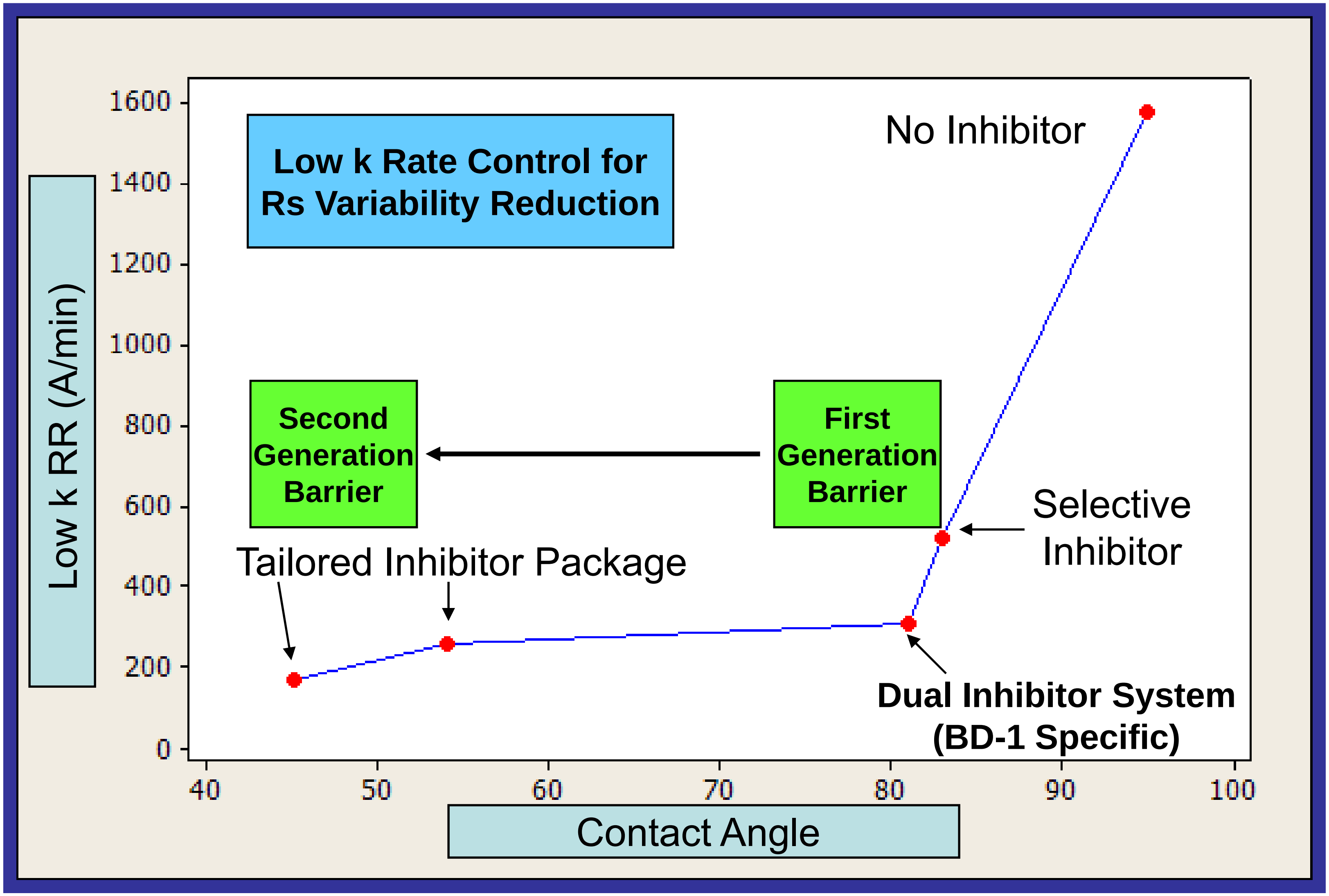
100um step Planarization



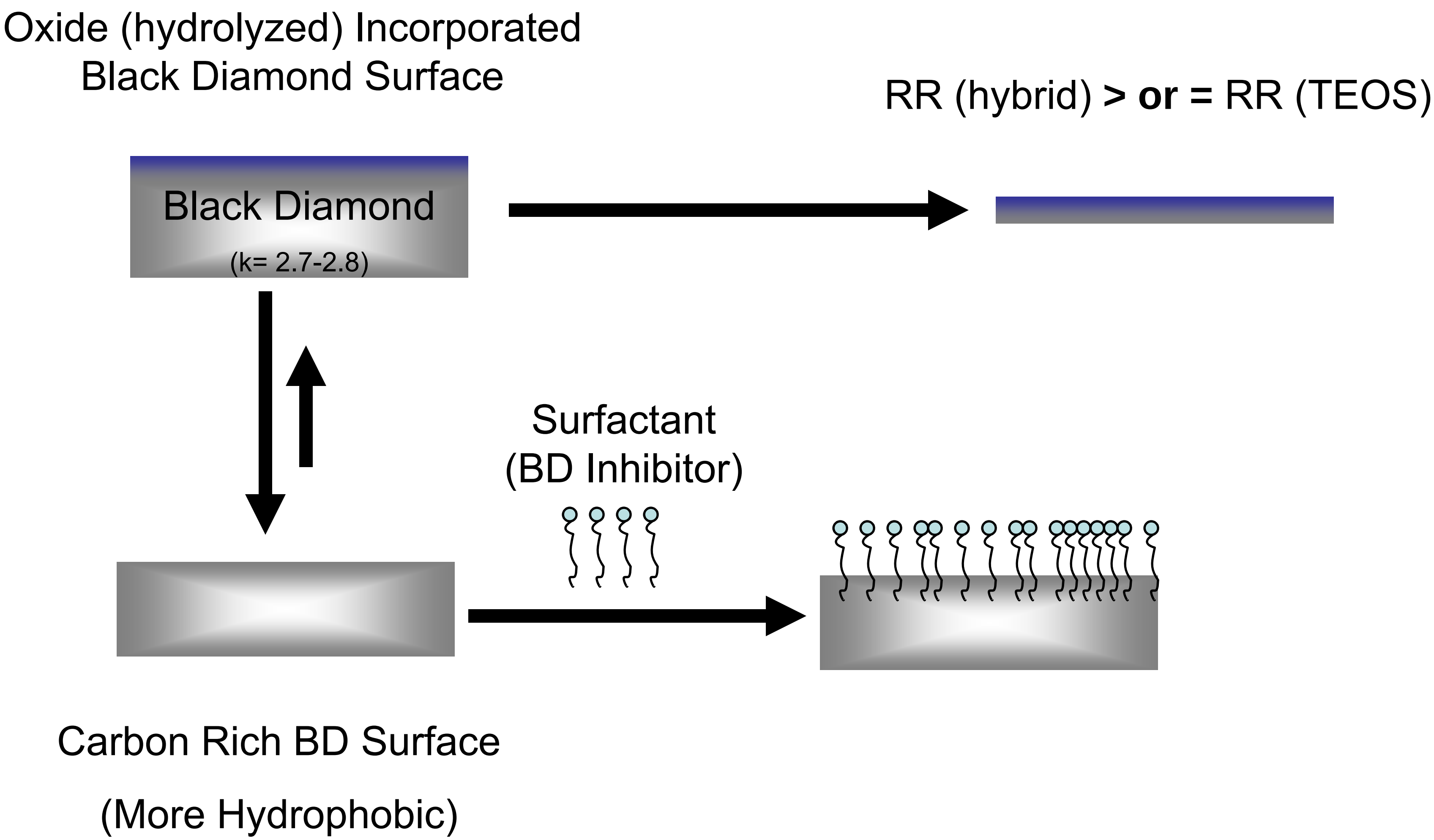
Cu Dishing & Erosion



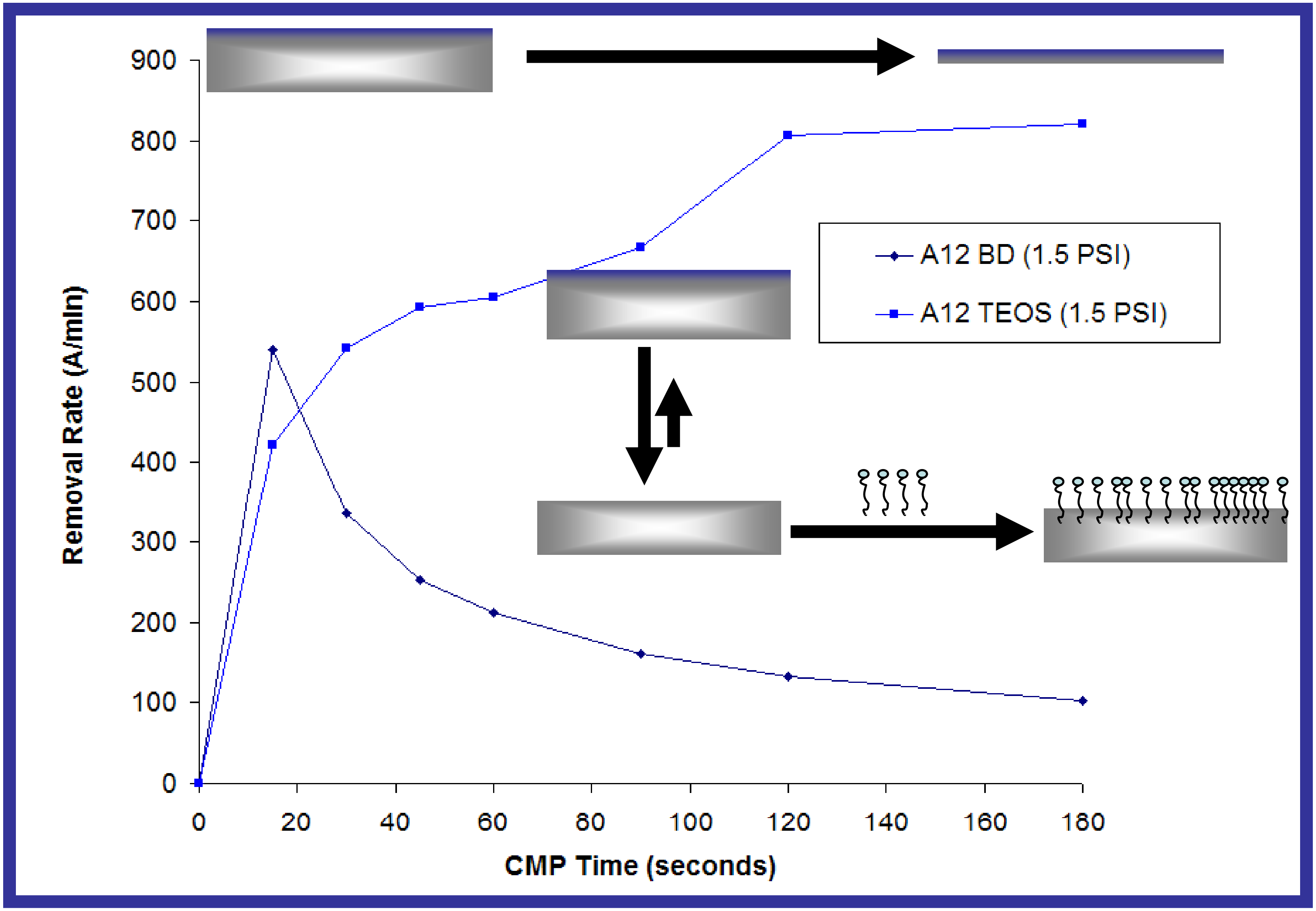
Impact of Wettability on Low-K Rate



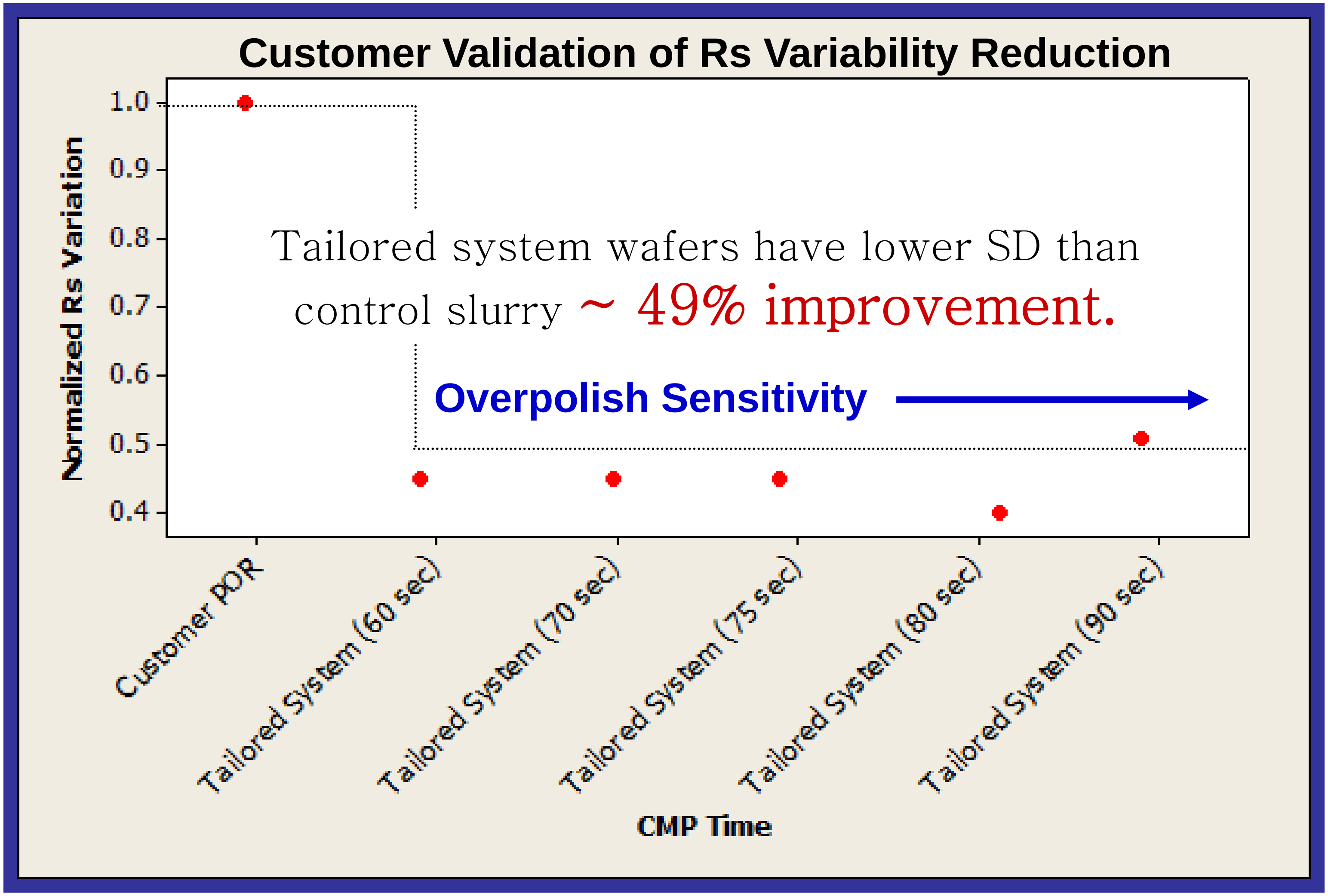
Low K Removal Mechanism



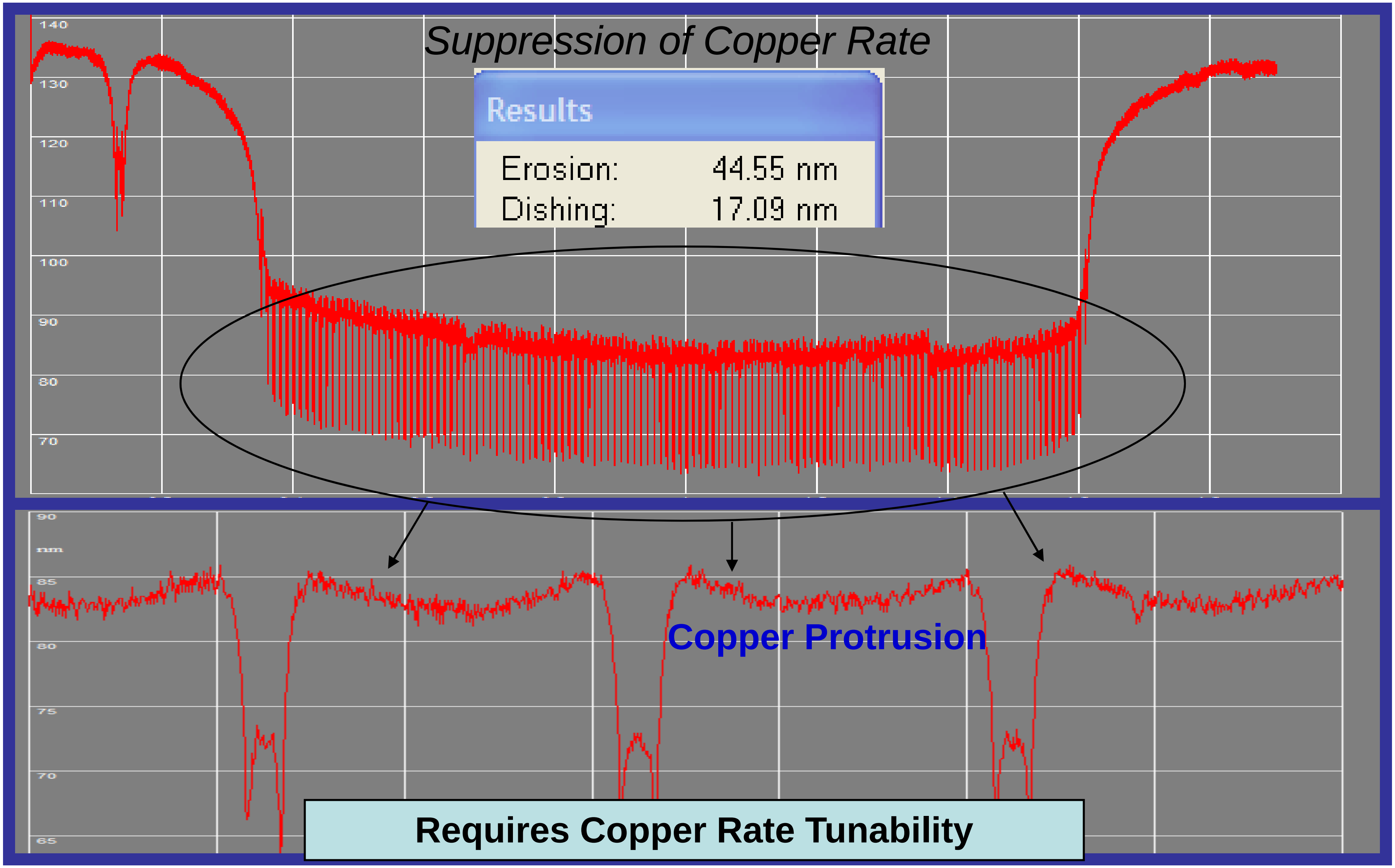
Verification of Mechanism



Tailored System Shows Enhanced Rs

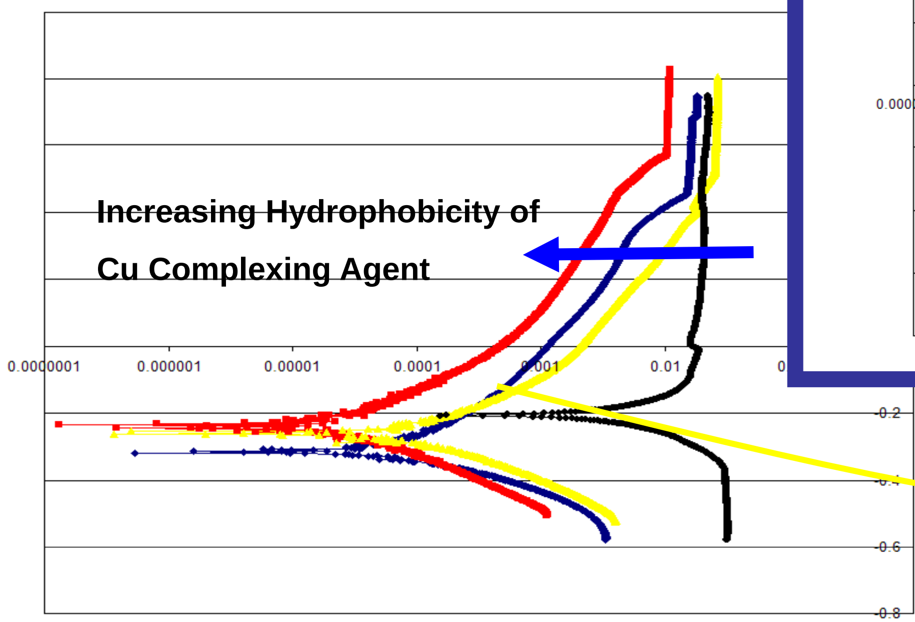


Drawback of Passivation Chemistry

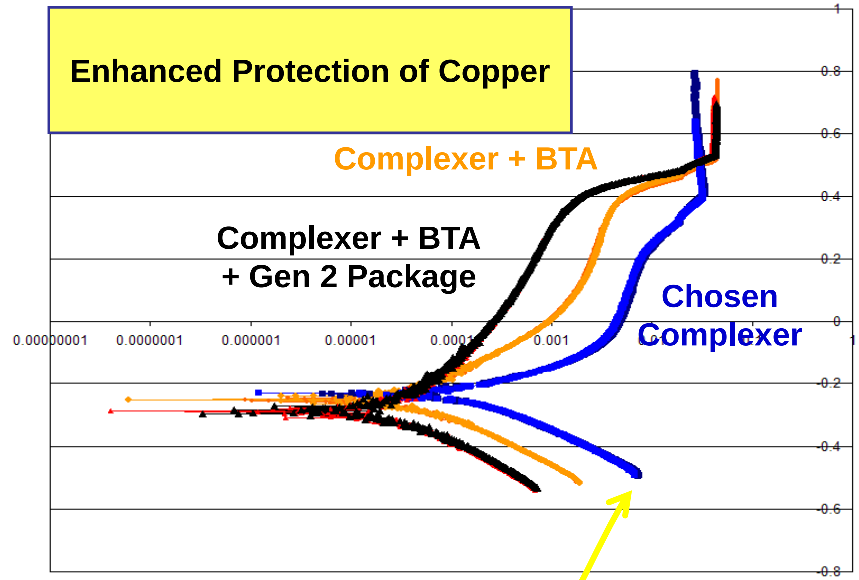


Copper Rate Control Mechanisms

- **Film Formation Control—Rate Suppression.**
  - Inhibitor Level—BTA for example.
  - Oxidizer Level—Peroxide for example.
- **Promotion Chemistry.**
  - Complexing Agent.
    - Structural Control.

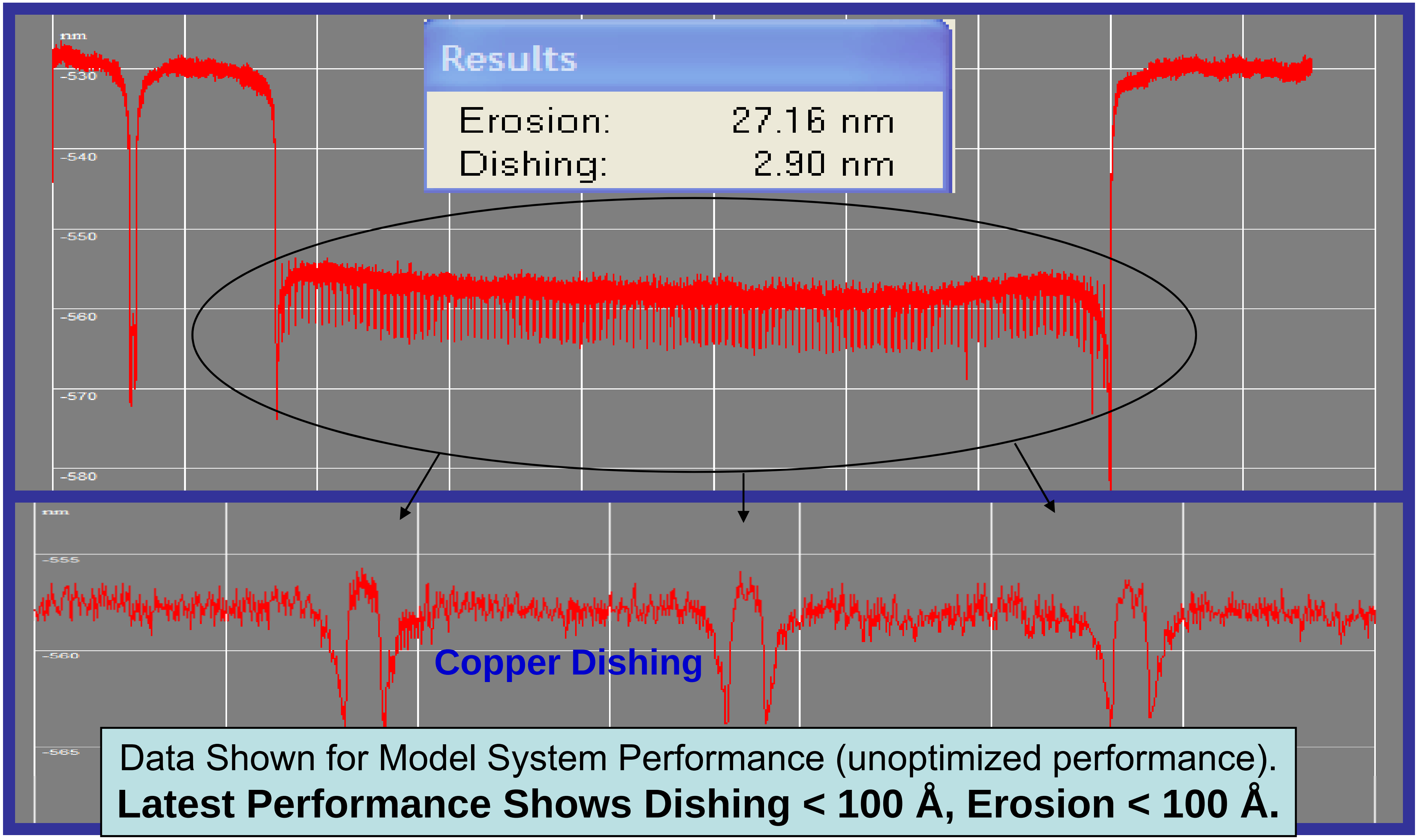


Validation of Robust Film



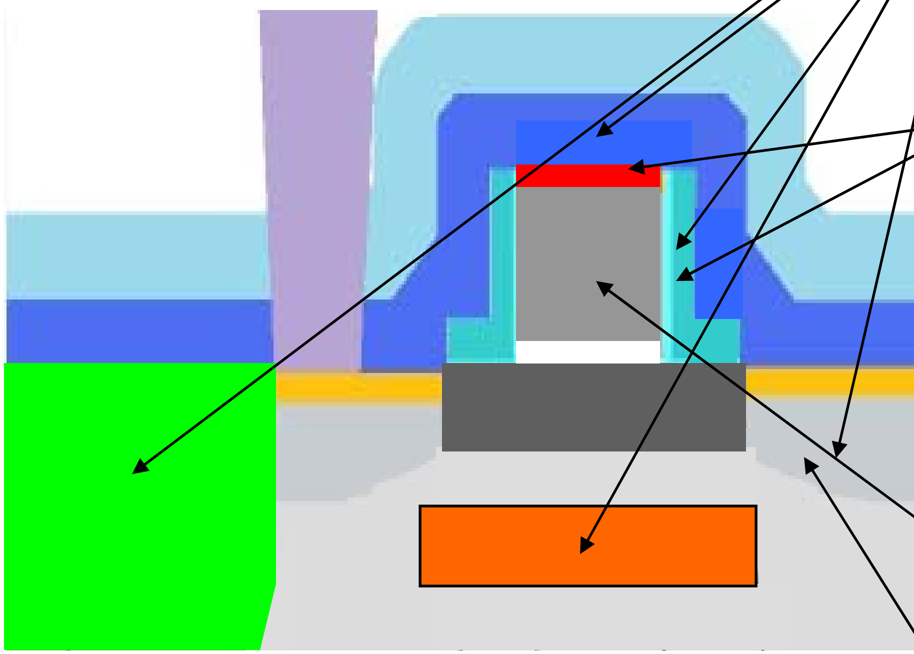
Yellow chosen based on balance between Film Formation and Removal

Increased "Chemical" Cu Rate Reduces Protrusion



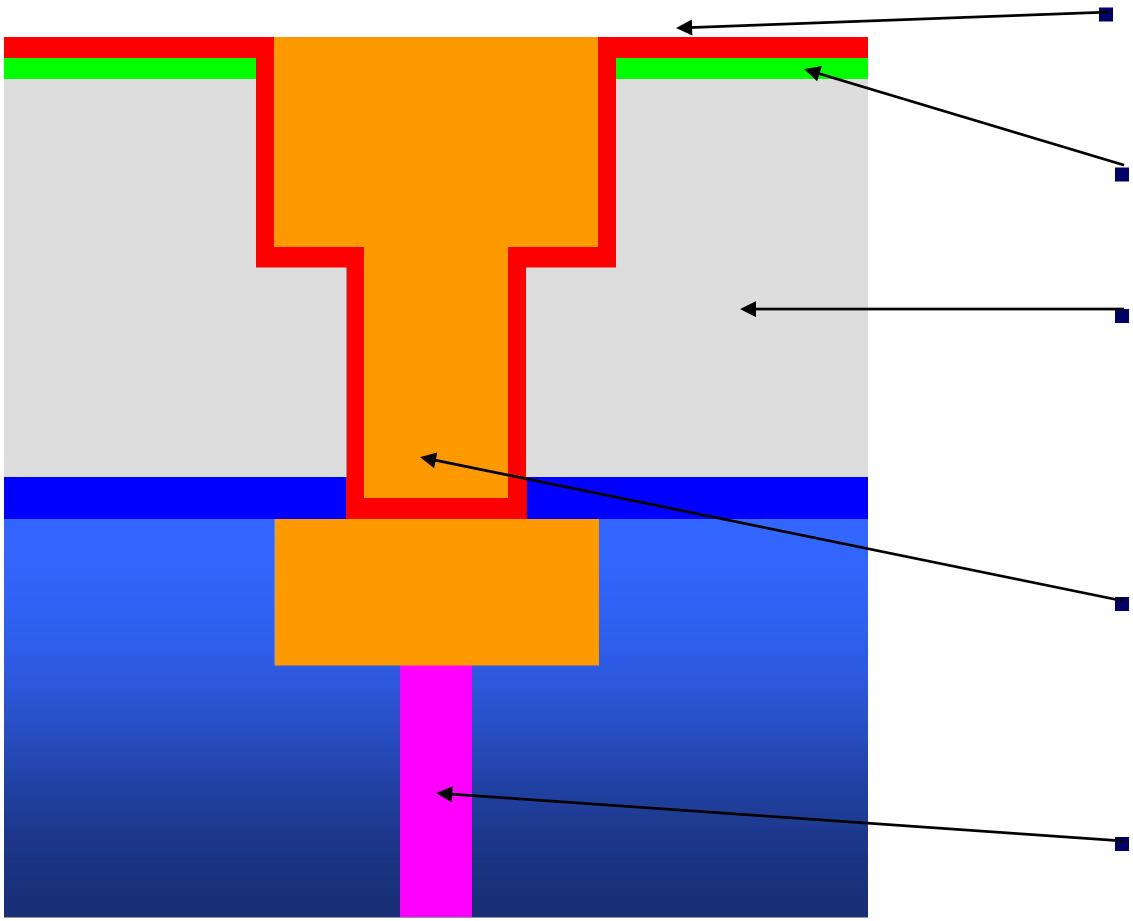
Data Shown for Model System Performance (unoptimized performance).
Latest Performance Shows Dishing < 100 Å, Erosion < 100 Å.

New CMP Applications In FEOL



- Strain Engineering
  - eSiGe, SiC, Si_3N_4
  - Selective and non-selective CMP steps
- Replacement Metal Gate
  - New Dielectric
    - Poly/Ox/Nit non-selective
    - Ox and/or Nit stop on Poly
  - Metal Damascene
    - Metal Silicides (NiSi, CoSi, YbSi, etc.)
    - Al, TaCN, Ru
- New Transistor Structures
  - New Dielectric
    - Nit stop on OX, Nit/Ox non-selective
- Si Replacement
    - Ge, III/IV (InSb), InGaAs

New CMP Applications In BEOL

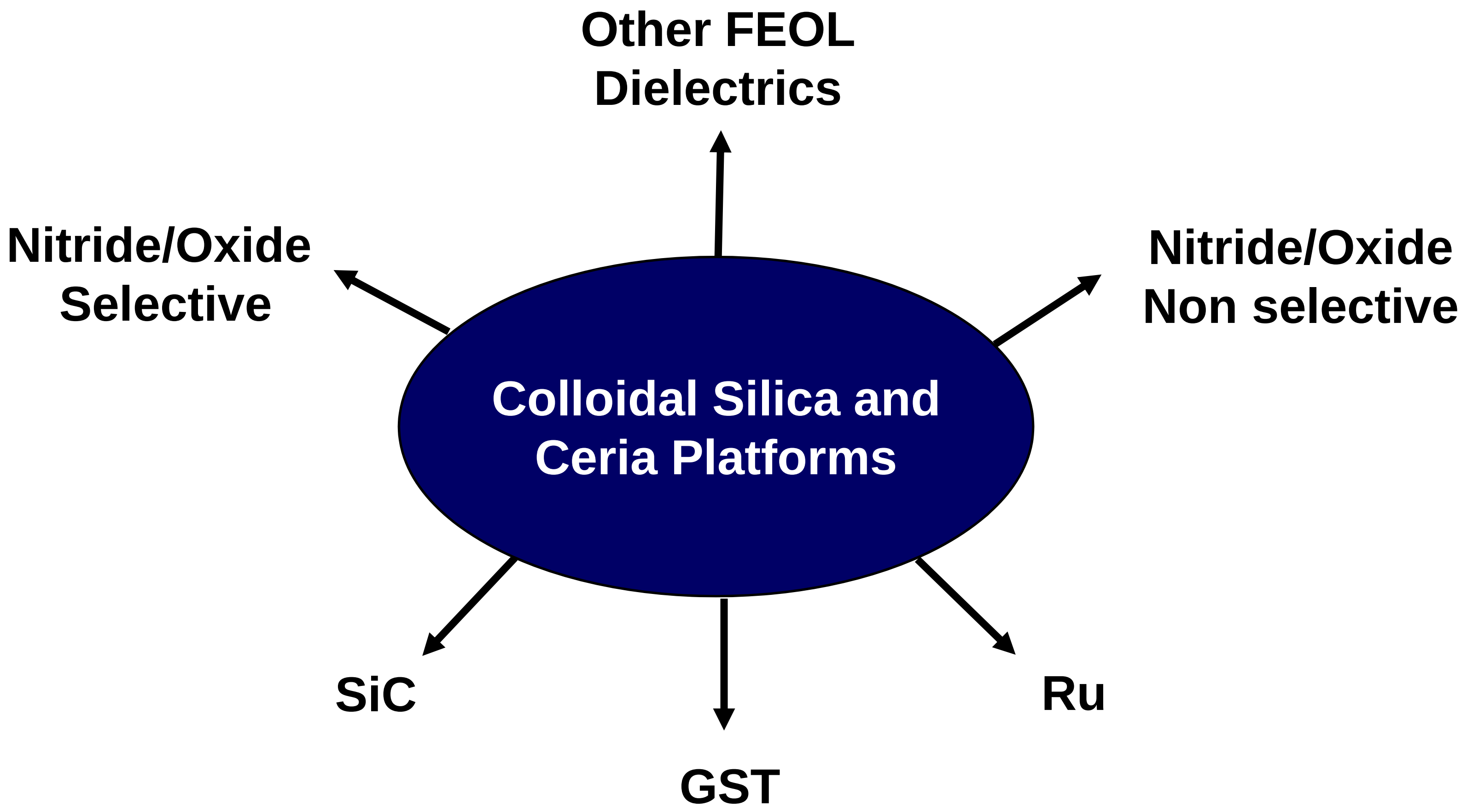


- Alternative Liner CMP
  - Ru, CuMn
- Dielectric Cap
  - Carbides, Nitrides
- New Dielectric CMP
  - Porous Low-k
  - Air Gap
  - Low Stress CMP?
- Metal wire CMP Other than Cu?
  - Al?
- New Contact Metal CMP
  - Cu, Rh

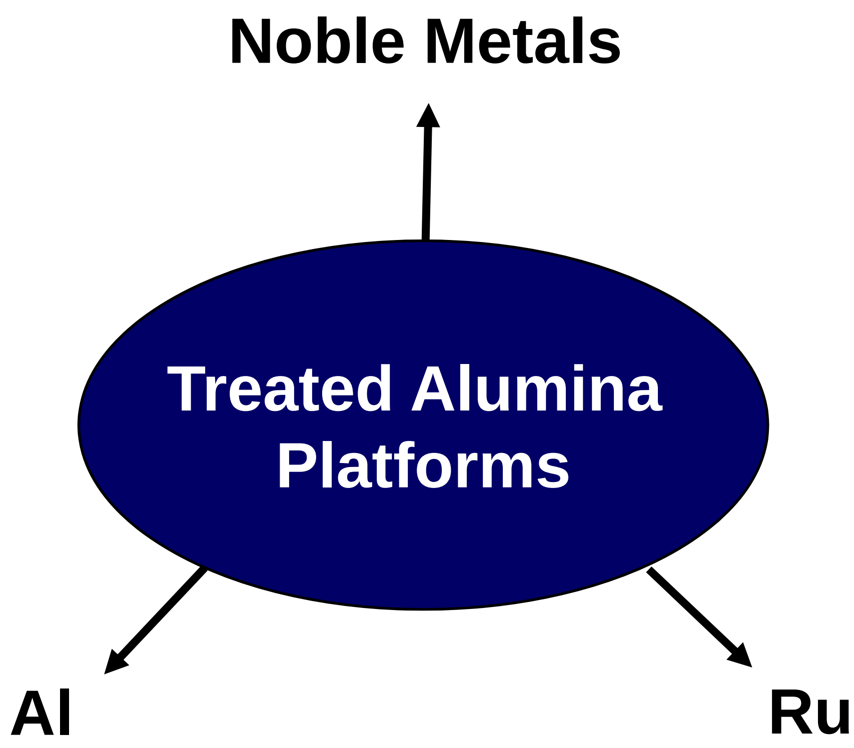
Additional New IC Related CMP Applications

- DRAM
  - New capacitor materials: Ru, TiN, Noble Metal?
  - Advanced poly CMP with high planarity
- FLASH
  - "Reverse" Poly for floating gate
- New Non-Volatile Memory
  - PRAM (GST CMP)
  - FeRAM (Noble Metal)
- 3D IC's
  - Through Si Vias
  - Thinning

Emerging Dielectrics and Exotic Materials



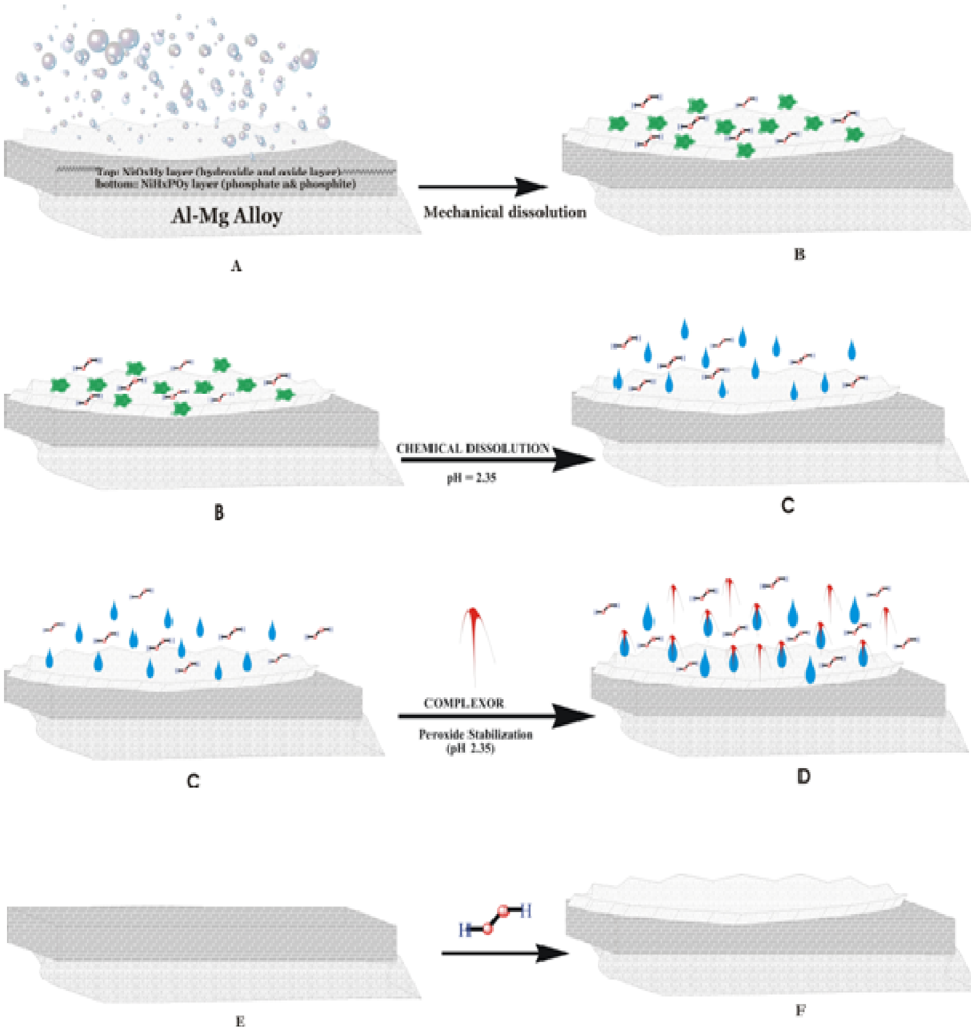
Emerging Metals and Exotic Materials



Developing Finishing Solutions for Multiple Applications

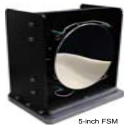
- Prime Silicon Wafer
- Flat Panel Displays
- Precision Optics
- Compound Semiconductor
- Healthcare
- Defense/Aerospace
- Solar Energy
- Data Storage/Hard Disk Drive

L8821 Slurry Technology



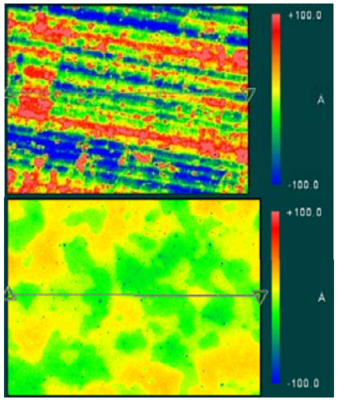
1. **Unique complexer stabilizing H2O2 for consistent removal rates**
2. **> 10 mg/min removal rate over pad life for greater throughput with 7-9 nm size particles**
3. **~1A surface roughness (AFM R_a)**
4. **Less scratch severity**

ESF Opportunities - Examples



Aluminum Mirror Polishing

Producing the best aluminum mirrors



Single Point Diamond Turning
•Grating effect due to turning marks
•Limited to > 50A rms
•Use limited to narrow frequency range

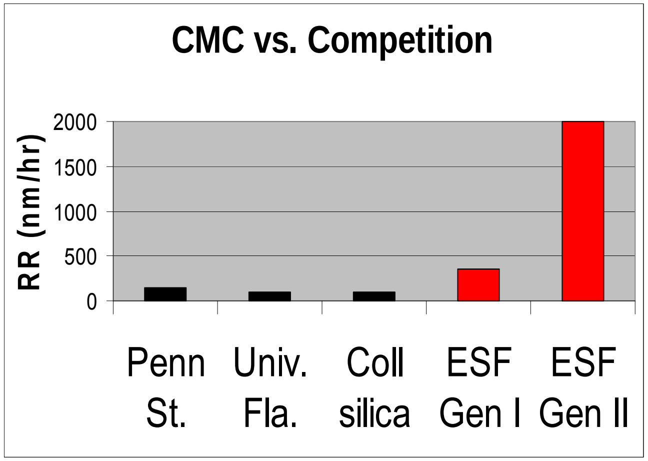
ESF Polishing process
✓No grating effect
✓Achieve < 15A rms
✓Enable use in wide frequency range

Silicon Carbide Polishing

Enabling higher rate

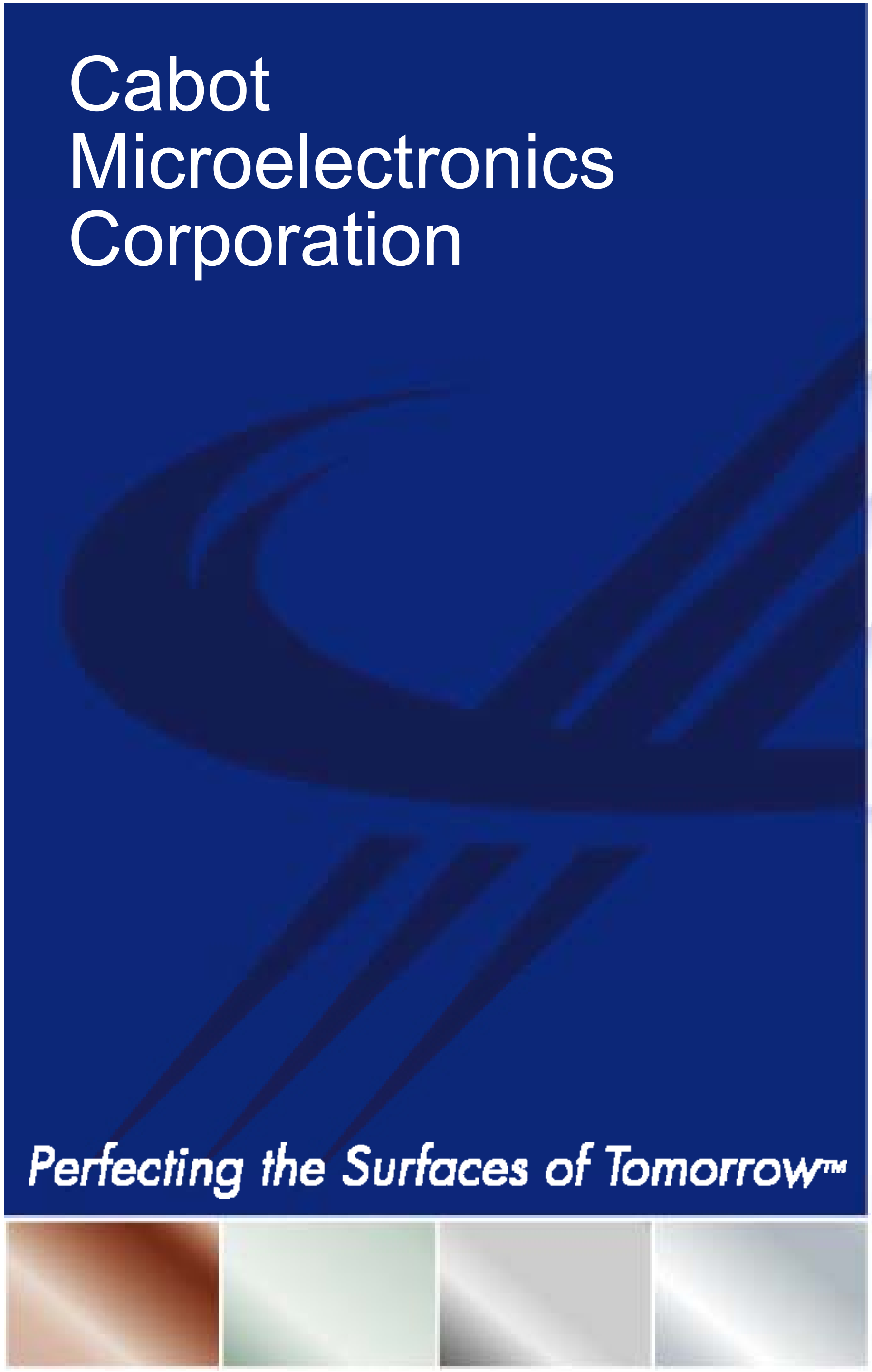
ESF Gen I - commercialized
✓2 X rate vs. POR
✓Achieve 1 A rms reliably

ESF Gen II – In development
✓10 X rate vs. POR
✓Achieve 1 A rms reliably



Summary

- Growing number of CMP applications drives strong need for consumables innovation
- Innovation being achieved to support IC needs
- Technology being extended outside of IC's



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