

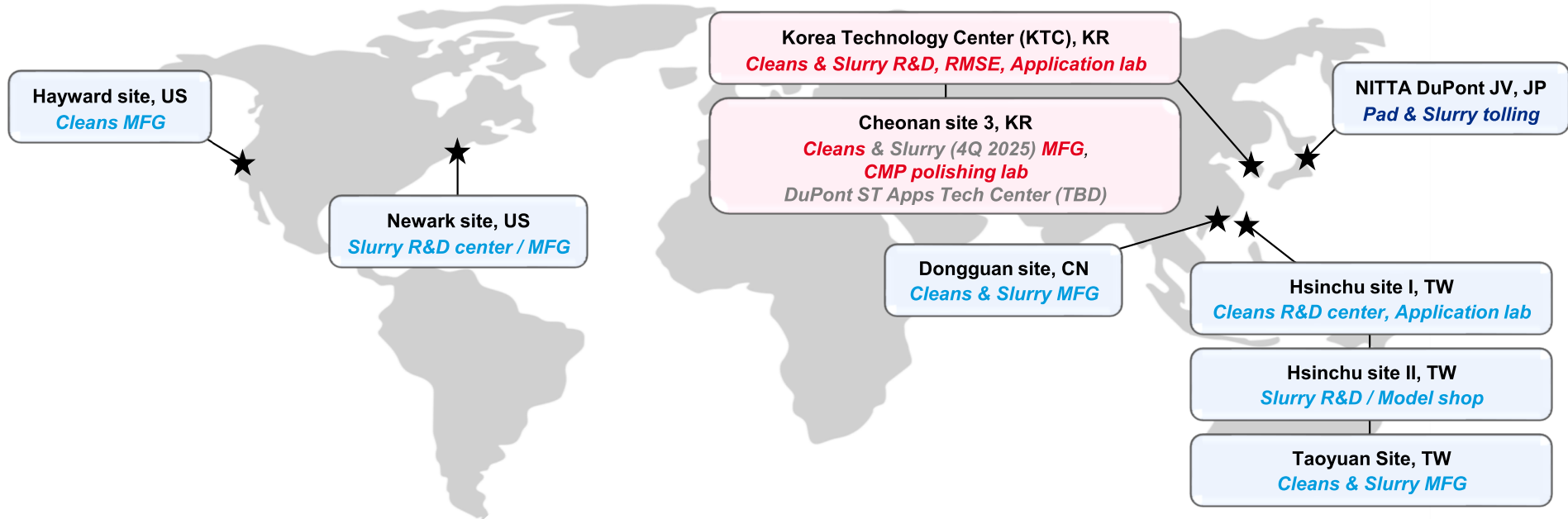
Tailored Cleaning Solutions for Advanced Packaging Needs

December 2024

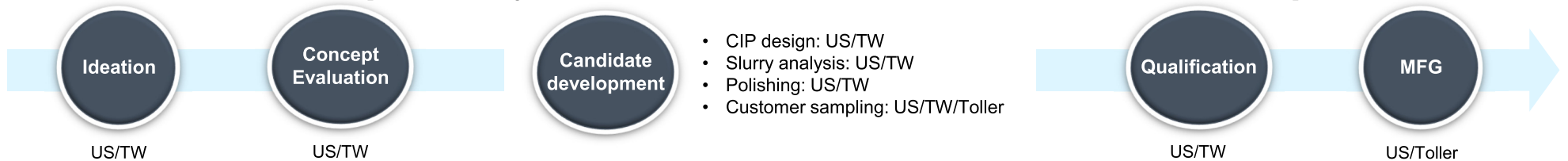
Advanced Cleans & Slurry Technologies
DuPont Electronics & Industrial

A person standing on a hill at night, holding a bright flashlight that illuminates the sky and the foreground. The background shows a starry night sky with the Milky Way galaxy visible.
DUPONT™

DuPont ACST Global Footprint



[Current Slurry and Cleaner products development workflow for worldwide customers]



Cu PCMPTM Roadmap

In Production

Experimental

Cu PCMP		Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Device node	Logic		10nm		7nm		5nm	4nm	3nm		2nm	
	DRAM		D1x		D1y		D1z		D1a	D1b	D1c	D1d
	NAND		Planar	64L		92L	128L		192L	238L	3xxL	
Products	Advanced Barrier	GEN III : Alkaline										
		14nm Co compatible, initial ACST offering										
		GEN III CIP1 : Alkaline										
		10nm Co compatible, wider window of organics										
	Ta/TaN Barrier	GEN VI : in development Alkaline										
		Ru, Mo compatible, wider cleaning window										
		GEN II : Alkaline										
		High volume proven										
Advanced Packaging: Alkaline	Memory Ta/TaN BM : Alkaline											
	Improved cleaning, Cu/ER controllable											
	Memory Ta/TaN/Co BM : Alkaline											
	Improved organic clean, re-dep prevention Low Cu/Co E/R											
Advanced Packaging: Alkaline	Advanced Packaging: Alkaline											
	Reduced Cu/Si re-deposition Surface modification, residue and particle clean											

- Comprehensive product portfolio for diverse Cu PCMP application fields.
- Experimental CU422 series are under testing at major advanced packaging customers.



Critical to Success in Advanced Packaging

Technical Complexity of AP

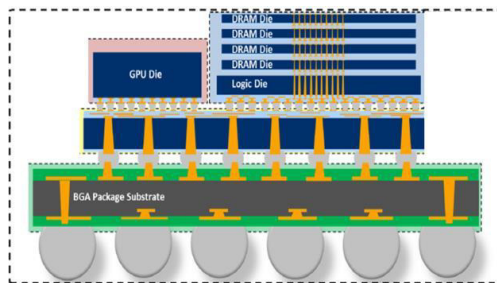
CMP Focuses

Clean Focuses

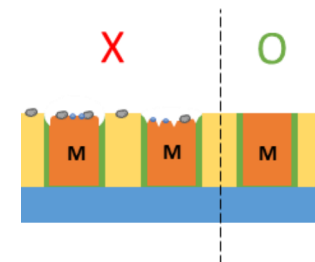
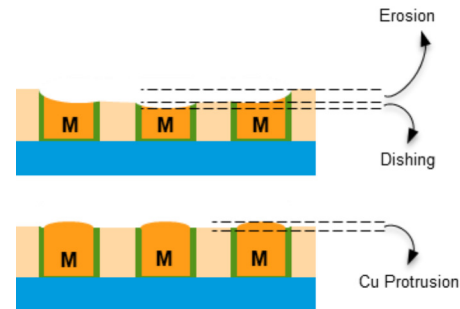
Integration Complexity
Planarization Requirement
Material Diversity
Defectivity

Metal/Dielectrics/Polymer
Removal Rate & Selectivity
Topography Control
Residues/Defects

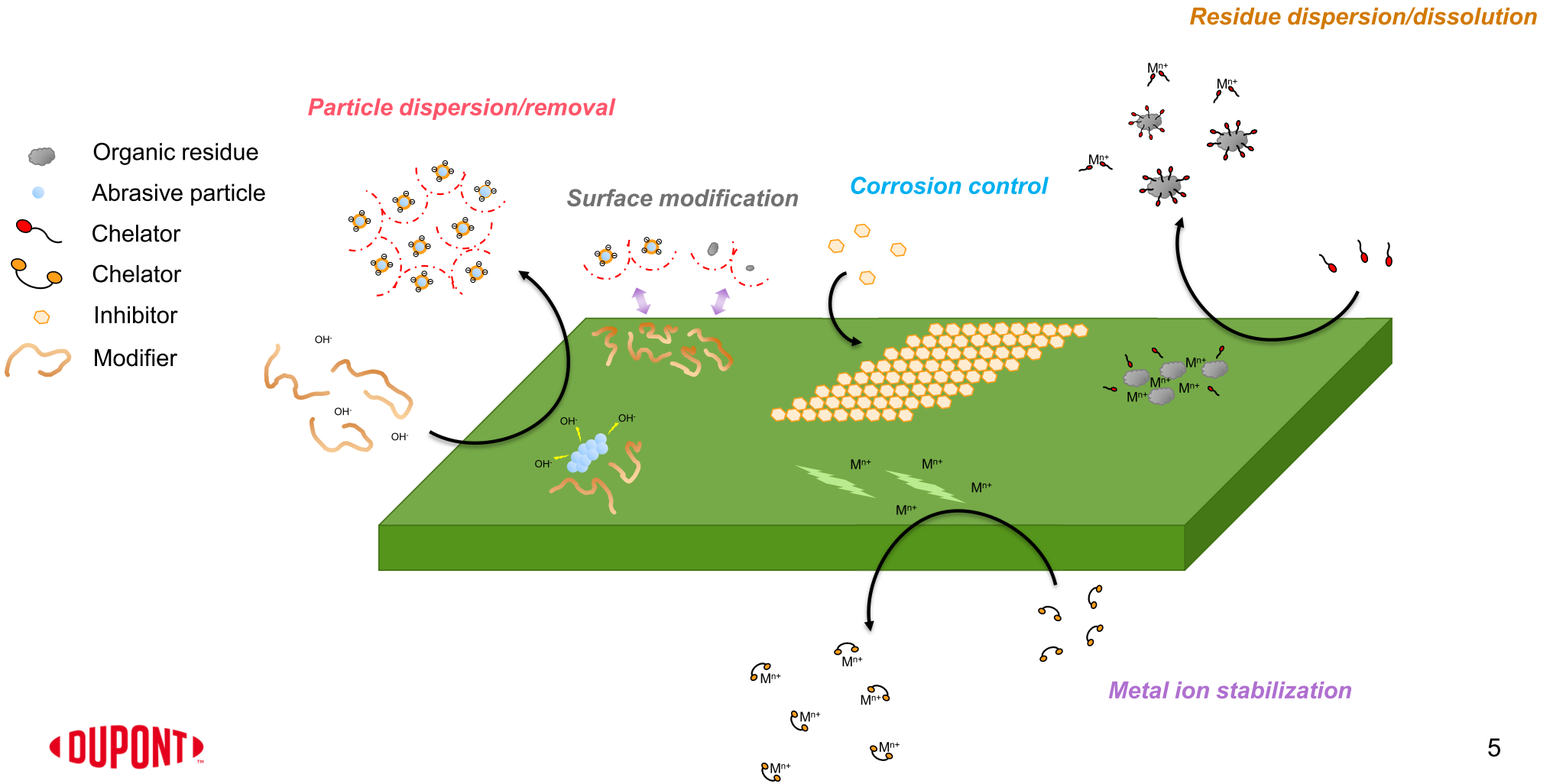
Residue Removal
Particle Dispersion/Removal
Corrosion Control
Synergy of Buff and Brush



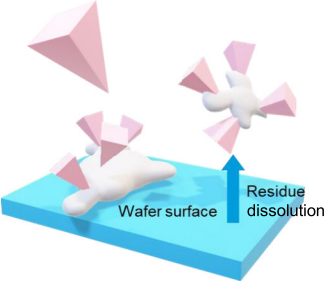
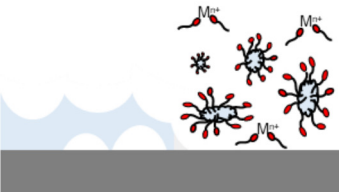
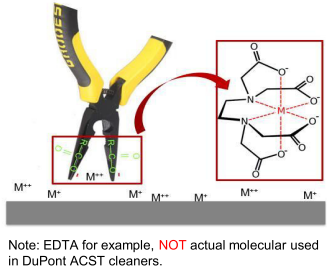
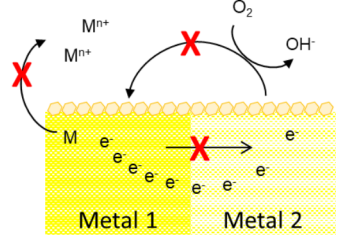
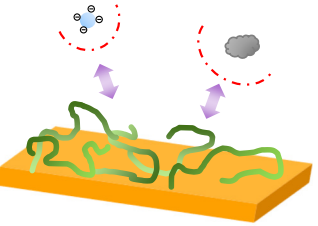
Not to scale



Design Concept of ACST's Cu PCMP Cleaners

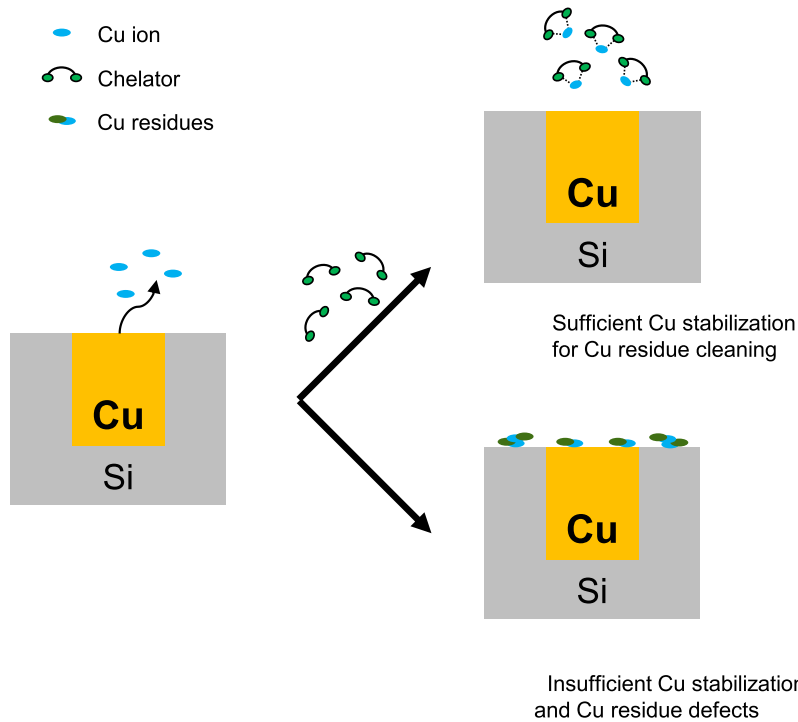


Component Function of ACST's Cu PCMP Cleaners

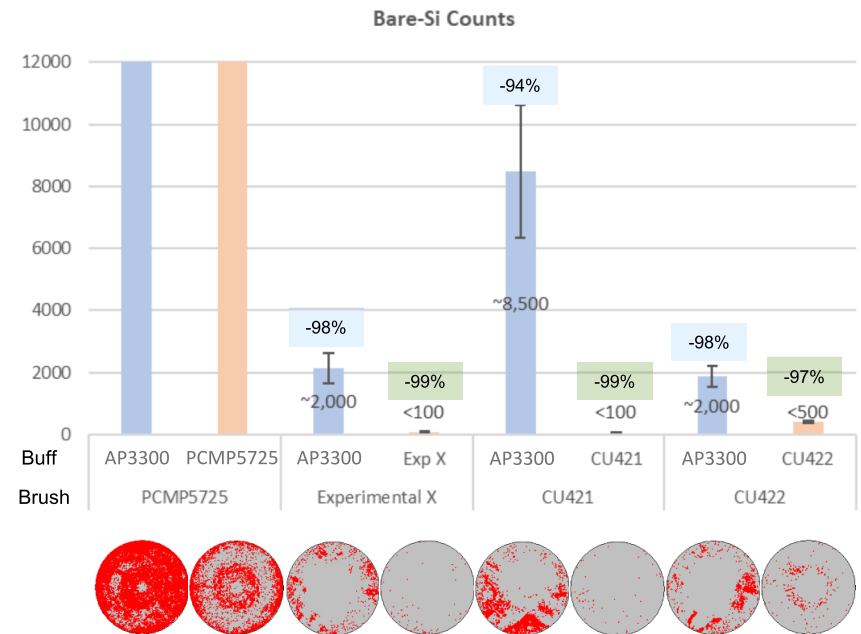
Components	pH Adjustor	Chelator		Corrosion Inhibitor	Surface Modifier
Function	Particle and organic residue removal	Metal and organic residue removal	Metal impurity and small particle removal	Corrosion inhibition and roughness control	Small particle removal Surface wetting
Mechanism	<ul style="list-style-type: none"> Negative zeta potential High organic complex dissolution rate 	<ul style="list-style-type: none"> Chelation/stabilization of metal ions Dispersion of organic residues 	<ul style="list-style-type: none"> Chelation/stabilization of metal ions pH buffer 	<ul style="list-style-type: none"> Passivate metal surface for good metal compatibility 	<ul style="list-style-type: none"> Affinity to substrates to steric hindrance.
Scheme	<p>Ensure proper surface charging and residue dissolution</p> 	<p>Strong chelation to metal-organic complexes to stabilize metal ions and disperse organics</p> 	<p>Strong chelation to metal ion to control the trace metal in the system</p> 	<p>Steric hindrance to prevent metal hydrolysis and galvanic corrosion</p> 	<p>surface modification to create steric hindrance</p> 



Universal Clean Formulation for Buff and Brush Clean in Cu TSV



- Tool: Ebara F-REX300X
- Slurry: LKA-40
- Polishing Pad: VisionPad™ 5000



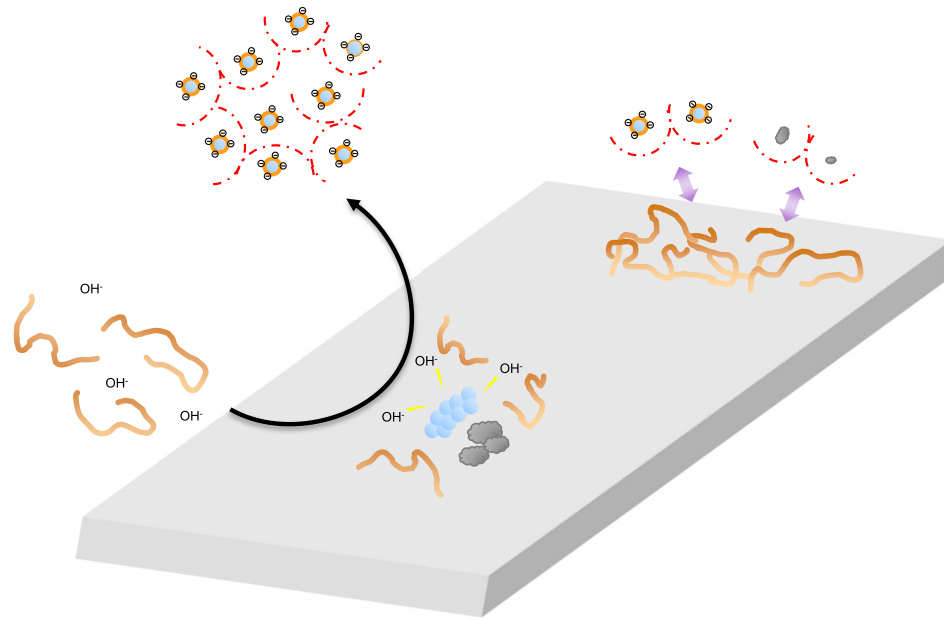
- Surface modifier and chelator for CU421 and CU422 and Experimental X.
- Buff process is key to BareSi clean performance
- PCMP5725: Commercial Cu PCMP clean in advanced logic application.

2 order of defect improvement is achieved by using one chemical for buff and brush clean.

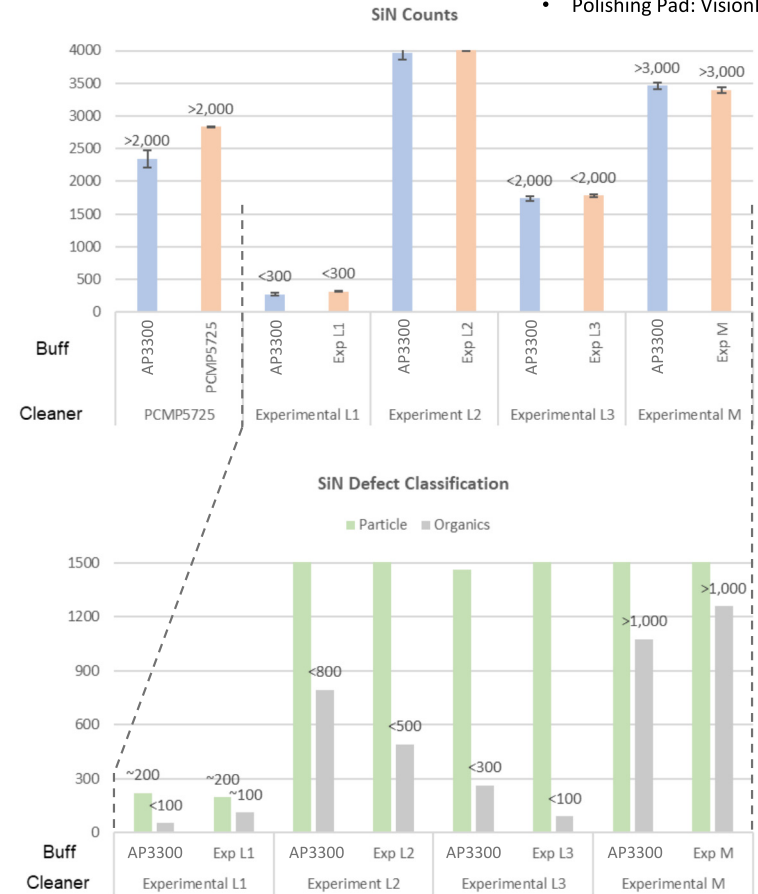


Unique Surface Modification for Cu/SiN Clean

- Tool: Ebara F-REX300X
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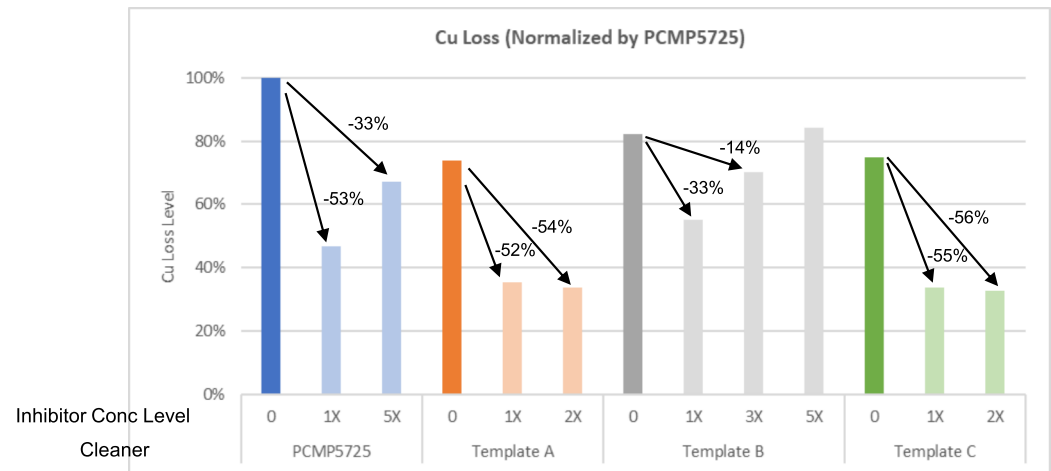
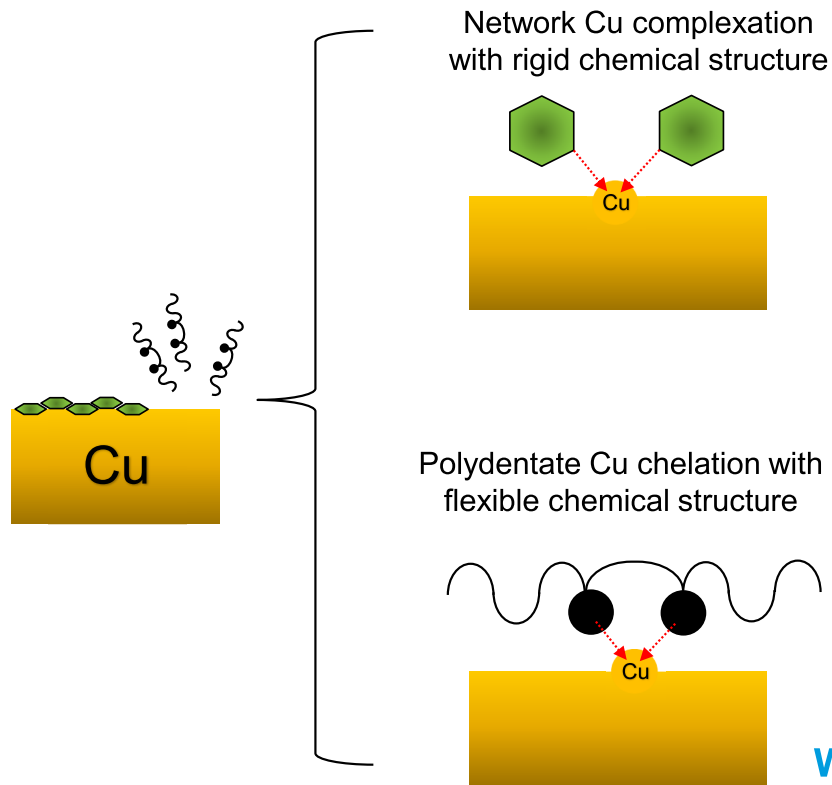


Controlled chemical structure and molecule size ensures desired surface modification and clean.



- SiN surface modification is key to clean and defect types.

Special Cu Corrosion Control with Biased Voltage



- Applicable in wide pH range.
- Template effect for optimized inhibitor conc.

Wide chemical library of flexible polydentates for Cu inhibition.

Summary

1. While leading Cu PCMP in logic and memory fields, DuPont ACST remains dedicated to developing technical solutions for advanced packaging applications.
2. CU422 series are designed for Cu/BareSi, Cu/SiN and special Cu control applications with tunable performance for various customers.
3. Synergy of slurry and cleaner technologies is demonstrated to be a powerful approach for developing a total solution for industrial needs.



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