Introducing Advanced PCMP Cleaning Solutions

With Surfactanized Metal Inhibitors and Oxygen Scavengers
New Particle Remover

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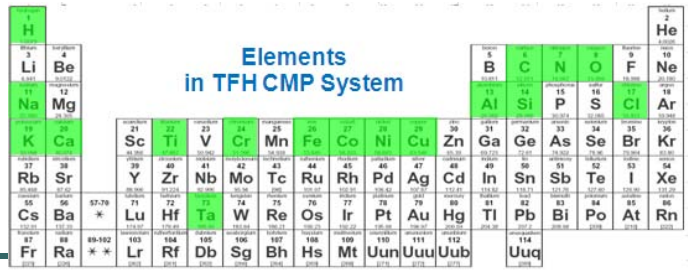
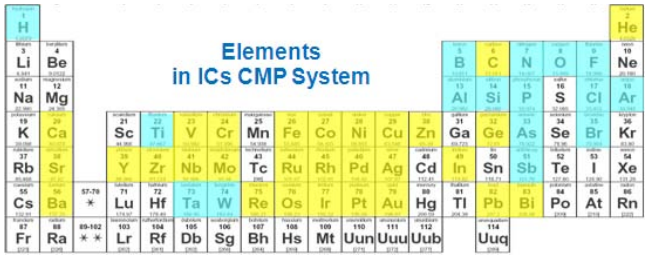
Challenges of PCMP Cleaning Solution

- **Multiple materials in Dynamical CMP and PCMP system**
  - Trace metals and ions: Cu, Ni, Fe, Ru, Ti, NiFe, CoFe, Cr, etc)
  - Dielectric material SiO2, Al2O3, etal.
  - Slurry residuals, PSD.
  - Organic polymer materials
- **Cleaning magnesium for different materials**
  - Cleaning chemistry vs. CMP chemistry, pH, Oxidation, Corrosion, Inhibites,
  - Metal surface cleaning
  - Dielectric surface cleaning
  - Wafer surface topography, structures, and Macro & micro- scratching
- **Cleaning Tool and Cleaning functions**
  - Roll-Roll Brushing, Pencil brushing, Masonic, risibility, dry methods
- **Wafer quality, CMP process performance**
  - Wafer aging, CMP process performance; Recontamination
  - partial dried wafers, wafer surface slurry residual pre-treated;

TFH CMP	
MATERIAL	
1	AlO_x
2	ALD
3	SiO_x
4	Ni_xFe_y
5	CoFe
6	Cu
7	Ta
8	TaO
9	Ru
10	Cr
11	SiN
12	TiN
13	C
14	PR
15	AR3
16	HB
17	Redep





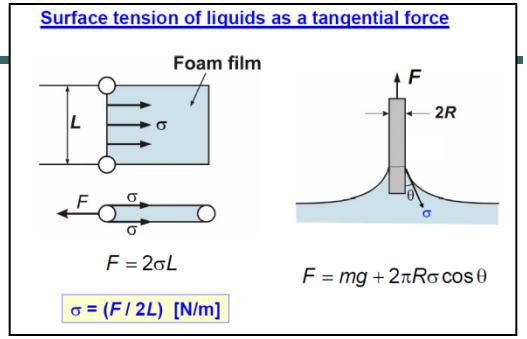
Key Issues of Cleaning Chemistry

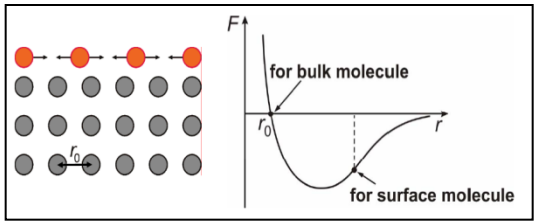
- **Unbalanced of Hydrophilic/Hydrophobic of Surfactants**
  - Poor Vehicle of Slurry
    - Poor uniformity slurry alone the pad
  - Poor Surface modification on Particles, such as SiO2
    - Aggregation of Particles
    - Wide distribution of particles - Macro- and micro- scratching
  - Residual slurry particles, Al2O3, Colloid SiO2

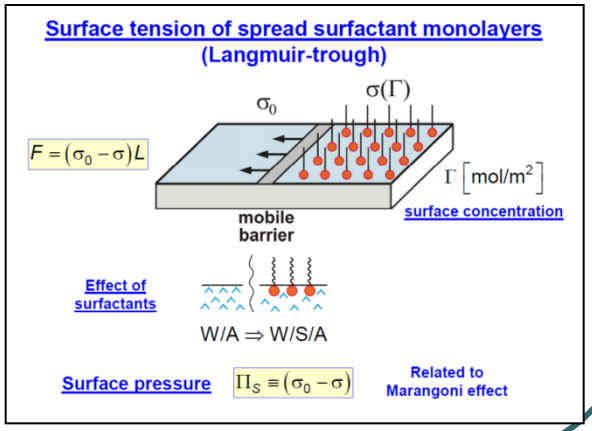
- **Incompatible of Metal Inhibitors/Oxygen Scavengers**
  - Ununiformed dispersion of particles in the solution
    - Corrosion of metal
    - Recontamination
  - Aggressive Chemicals or high, low pH
    - Corrosion
    - Macro- or micro – Scratching
    - Poor re-rinsibility

Cleaning Classification Fundamental

- **Cleaning magnesium**
  - Hydrophilic/Hydrophobic balance
  - Surface tension
- **Metal cleaning with inhabitable (BTA),**
  - Better removing particle,
  - Corrosion on metal
  - pH range
- **Classic Non-ionic Surfactants (NIS)**
  - Removing particles
  - Removing Organic Contaminations
- **Ionic Surfactants (IS)**
  - Aliphatic phosphorous surfactants
  - Metal surface protection
  - Residual mono-layer
- **Chelating/Complex Chemicals**
  - Cleaning/removing metal ions, and oxides







New Concept

- Surfactanized Metal Inhibitor and cleaning functions

- **Surfactanized Metal Inhibitors**
  - Hydrophilic metal inhibitor on one side
  - Short aliphatic hydrophobic tail
  - Maximized protection on metal, Ni, Fe and Cu
- **Surfactanized Oxygen Scavengers**
  - Long ethoxylated hydrophilic tail
  - Hydrophobic oxygen scavenger
  - Max scavenged oxygen in whole CMP process
- **Special Surfactants**
  - Ethoxylated hydrophilic tail
  - Short hydrophobic chain with chelate agent
    - Not ethylenediamine series
    - Much better vehicle
- **Components**:
  - Special Non-ionic surfactants
  - Mixed Surfactanized Metal inhibitors
  - And Surfactanized oxygen scavengers
  - Additional Metal inhibitors - And Anti-oxidant agents
  - Chelating agents
  - Particle removing agene for particles, Al_2O_3, SiO_2 etal.

BriteClean System – How does it work

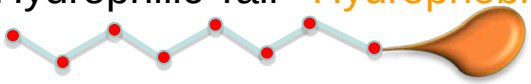
Hydrophilic
Metal inhibitor head

Aliphatic
Hydrophobic tail

+

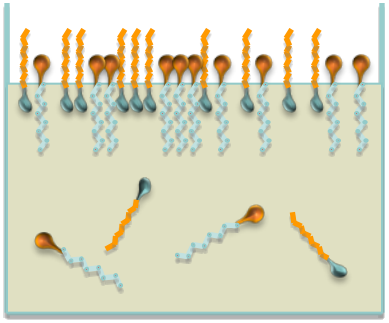
Ethoxylated
Hydrophilic Tail

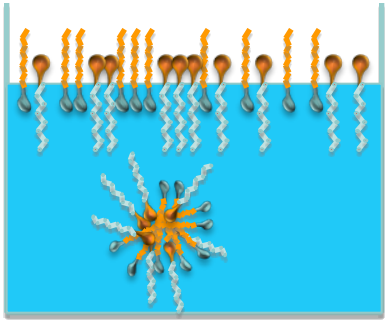
Anti-oxidant
Hydrophobic Head



Briteclean-0 (0plus)

Briteclean-1



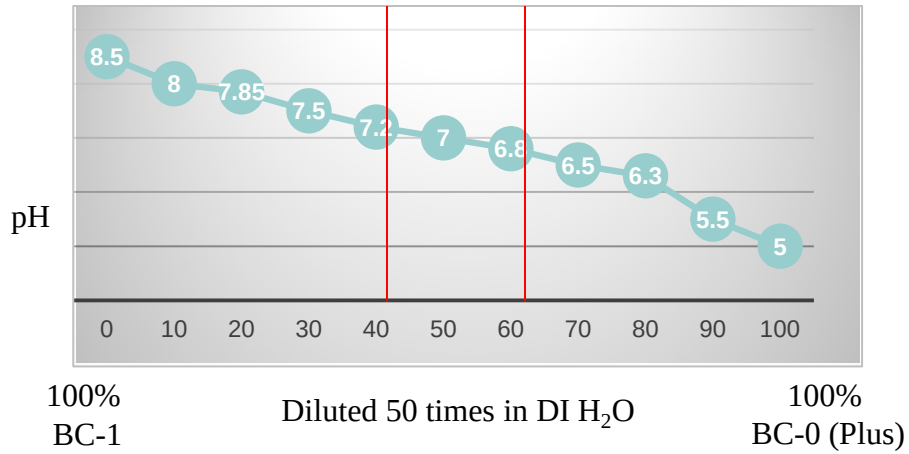


Briteclean-0:Briteclean-1 = 1:1
In 50 time aqueous dilution

Briteclean-0:Briteclean-1 = 1:1
No dilution

Phase separation

BriteClean System – pH Control and Application Conditions



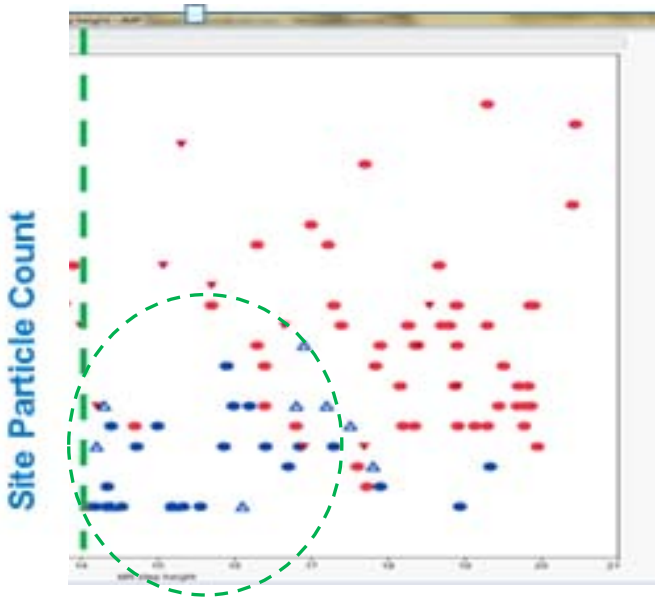
	Briteclean - 0/Plus	Briteclean - 1	Briteclean-ACP
Pre/Post Cleaning Process	YES	YES	YES
Slurry Additives	YES	YES	YES
Storage/Buffer	NO	NO	YES
Application	Need to mixing with BC-1 or BC-ACP	Need to mixing with BC-0/plus	Solely
Usage	1% - 5%	1% - 5%	1% - 4%

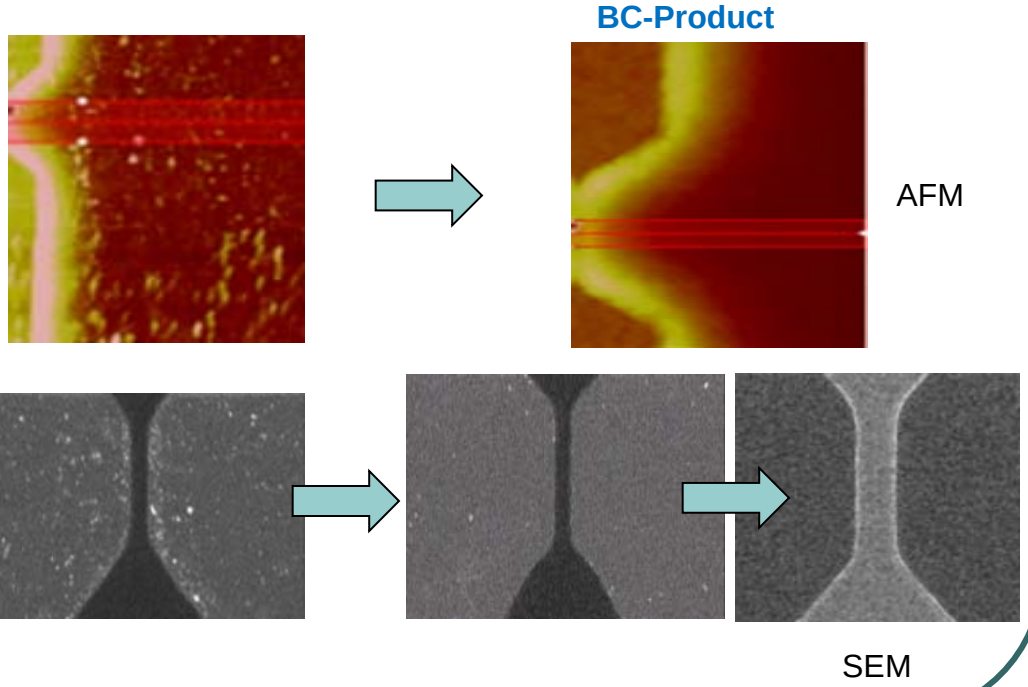
Recommendation: BC-0(plus)/BC-1 = 1:1; Diluted 1%-2% times with DIW

- **Process Conditions:**
  - CMP Tool (8inch): Applied Mirra; Ebara; 6DSSP(Strausbaugh)
  - Slurry: Cabot MH8xx system; ASL system
  - Pad applied: IC1000; Sub IV
  - Cleaning Tool: DNS, SSEC
  - Cleaning solution: Briteclean-0 and Briteclean-1; Briteclean-0plus
    - Mixed: Ratio 1:1 in 1.0% - ~2% Aqueous media
  - Wafer: Cu, NiFe, Low key, SiOx, Al2O3, CoFe, Ru, etc

BriteClean System –Applications

- **BriteClean Productions are qualified in production line and have been used as POR**
- **Particle Reduction**
  - BC cleaning system showed better particle count reduction
  - BC cleaning system showed >40% particle reduction on device production wafers

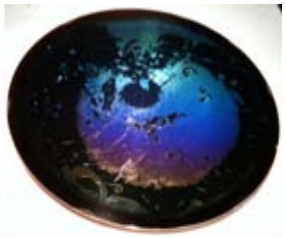


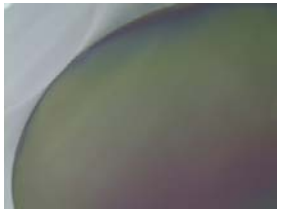


BriteClean System –Applications

- **Surface Quality improved**
  - Prevent AlOx wafer surface without pitting with BC products
  - Metal surface improved

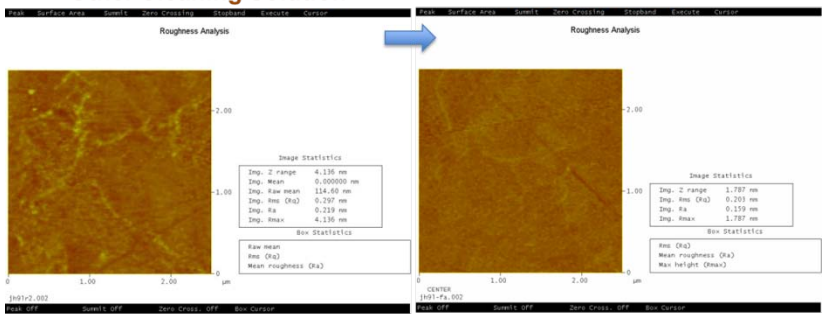
Full AlOx Film pitting – long time in DIW





No Film pitting – x2 long time in DIW+BC

Other Cleaning Solution **BriteClean Mixture**

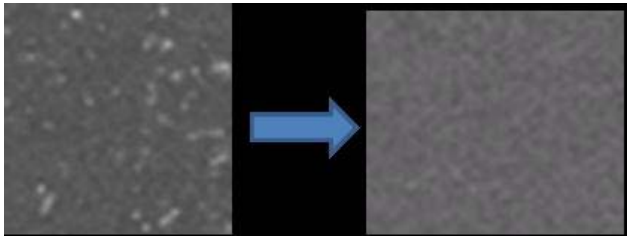


Average Roughness(N=3x3): Rms=0.34nm

Average Roughness(N=3x3):Rms=0.29nm

Cu AFM Image

Other Cleaning Solution **BriteClean Mixture**



Cu SEM Image

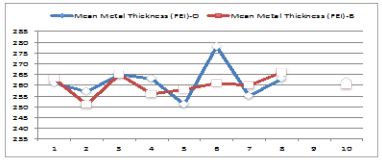
BriteClean System –Applications

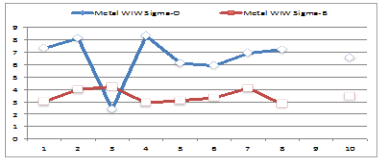
- **Briteclean Application repeatability**

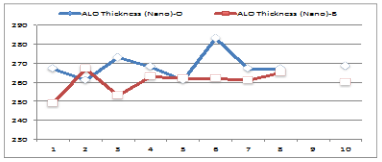
Layer X CMP Comparison

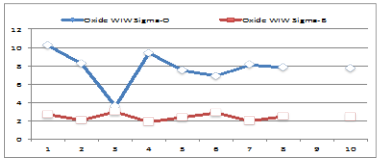
Wafer ID - Existing Slurry	Mean Metal Thickness (FEI)-O	Metal WIW Sigma-O	ALO Thickness (Nano)-O	Oxide WIW Sigma-O	Added Paticles
1	261	7.3	267	10.2	217
2	257	8.1	261	8.2	198
3	265	2.4	273	3.6	229
4	263	8.3	268	9.4	363
5	251	6.1	261	7.5	107
6	278	5.9	283	6.9	267
7	255	6.9	267	8.1	271
8	263	7.2	267	7.8	400
Mean	261.63	6.53	268.38	7.71	256.50
Std. Dev.	7.60	1.75	6.61	1.84	86.85
3 Sigma	22.79	5.24	19.84	5.52	260.55
Max.	278	8.3	283	10.2	400
Min.	251	2.4	261	3.6	107
Range	27	5.9	22	6.6	293

Wafer ID with Brite Additives	Mean Metal Thickness (FEI)-B	Metal WIW Sigma-B	ALO Thickness (Nano)-B	Oxide WIW Sigma-B	Added Paticles
1	263	3	249	2.7	30
2	251	4	267	2.1	0
3	265	4.2	253	3	139
4	256	2.9	263	1.9	271
5	258	3.1	262	2.4	0
6	261	3.3	262	2.9	225
7	260	4.1	261	2	57
8	266	2.8	265	2.5	68
Mean	260.00	3.43	260.25	2.44	98.75
Std. Dev.	4.64	0.54	5.72	0.39	96.27
3 Sigma	13.91	1.63	17.15	1.16	288.82
Max.	266	4.2	267	3	271
Min.	251	2.8	249	1.9	0
Range	15	1.4	18	1.1	271









Conclusions

- BriteClean Productions using new surfactanized metal inhibitor and anti-oxidant cleaning magnesium
- Cleaning all metal residuals, dielectrics materials, slurry residual and photo residual etc with one mixed solution.
- High cleaning efficiency with particle reduction and better surface quality
- Easier handling and simple Process on all tools
- The products have been qualified in production line and used as POR for over 2 years.
- More advanced products are available for better cleaning efficiency.

- **Acknowledgement**
  - NCCAVS
  - Western Digital
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