Introducing Advanced PCMP Cleaning Solutions

With Surfactanized Metal Inhibitors and Oxygen Scavengers
New Particle Remover

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Contents

- Challenges of PCMP Cleaning
- Background and Principle of PCMP Cleaning
- New Concepts of Cleaning Chemistry
- Fab Experimental Data and Results
- Summary
- Acknowledgment
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, et al.
  - 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;
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, Al2O3, SiO2 et al.
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

- **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

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

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BriteClean System – Applications

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

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**Full AlOx Film pitting – long time in DIW**

**No Film pitting – x2 long time in DIW+BC**

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**Other Cleaning Solution**

- **Cu AFM Image**
  - Average Roughness (N=3x3): Rms=0.34nm

**BriteClean Mixture**

- **Cu AFM Image**
  - Average Roughness (N=3x3): Rms=0.29nm

**Other Cleaning Solution BriteClean Mixture**

**Cu SEM Image**
BriteClean System - Applications

- Briteclean Application repeatability

Layer X CMP Comparison

| Layer ID | Mean | Median | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | Sigma | 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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

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