Ceria Slurry Reclamation and Recycling Systems used in High Volume, Semiconductor Manufacturing
Slurry Recycling:

- Why?
- When?
- Where?
- How?
- How Well? (Performance)
Slurry Recycling: Why?

- Costs - Consumables are a large percentage of semiconductor manufacturing costs

- Environmental Impact - an ever growing concern and in most cases a growing expense as well

- Slurry Performance – CMP slurries (especially Ceria slurries) are chosen because of unique polish performance, selectivity and low defect levels. To find new slurries with comparable results is difficult, time consuming and expensive.
Slurry Recycling: When?

- **2000 – 2004** Research and Development
- **2004 – 2006** Concept and Design Testing
- **2006 – 2009** Application Testing (CMP processes using recycled oxide slurry)
- **2009 – 2010** Pilot systems installed and qualified (oxide slurry)
- **2010 – Present** High volume manufacturing systems in production (oxide slurry)
- **2013 – 2014** Pilot systems installed and qualified (ceria & tungsten slurries)
- **2014 – Present** High volume manufacturing systems in production (ceria & tungsten slurries)
Slurry Recycling: Where?

- Europe
  - Germany: Oxide-Silica, Tungsten, Li Ta
  - France: Oxide-Silica

- South East Asia
  - Malaysia: Oxide-Silica
  - Korea: Oxide-Silica
  - Japan: Oxide-Silica

- North America
  - United States: Oxide-Silica, Oxide-Ceria
Ceria Slurry Recycling: How?

1. CMP Waste Water Collection
2. Pre Filtration
3. Recycle – Ultra Filtration
4. Final Filtration
5. Blending with Fresh Slurry
6. Storage with Proper Agitation
7. Delivery to CMP
Ceria Slurry Recycling: Modular Design

Buffer Tank
Permeate Tank
Recirculation Tank
Redundant Filters
Recycle Skid Module
Storage/Mix Module
Fresh Slurry Module
Chemical Supply Module
Ceria Slurry Recycling: Modular Design
Ceria Slurry Recycling: Quality Control-Operations
Ceria Slurry Recycling: How Well?(Performance)

- Polish Removal
- Defectivity, Micro-Scratching
- Long Term Stability
Ceria Slurry Recycling: Removal

Post polish silicon nitride thickness comparison on 65nm production wafers.

- The POR (2-step, 2-slurry) process mean was 1065Å (left) and the Reclaim (recycled ceria) was 1061Å (right).
- Customer reported result: “The difference is not significant.”
Ceria Slurry Recycling: Removal

Post polish trench or field oxide thickness comparison on 65nm production wafers.
- The POR (2-step, 2-slurry) process mean was 4734Å (left) and the Reclaim (reclaimed ceria) was 4741Å (right).
- Customer reported result: “The difference is not significant.”
Ceria Slurry Recycling: Defectivity

KLA-Tencor DN defect counts were statistically lower by 35% for the reclaimed slurry over the Standard (2-step) STI process.

35% Improvement

KLA-Tencor DW defect counts were statistically lower by 38% for the reclaimed slurry over the Standard (2-step) STI process.

38% Improvement
Customer reported result: “Classified extrapolated micro-scratch defect density was 34% lower for reclaimed slurry on 65nm production wafers.”
Customer reported result: “Very stable and consistent %total solid results from High-Q: %1.01 +/- 0.01 (normalized data)”
Customer reported result: “No buildup of Silicon in the Ceria slurry reclaim system over time: Silicon concentration well below 5ppm“
Ceria Slurry Recycling: Summary

- **Why?**
  - Slurry Costs
  - Environmental Impact
  - Ceria Slurry Performance

- **When?**
  - 2000 – 2013 Development
  - 2013 – Present High Volume Manufacturing with Ceria Slurry

- **Where?**
  - Cypress Technologies, Austin, TX
  - Next - TBD

- **How?**
  - Robust Design
  - Self Cleaning
  - Closed Loop Quality Control

- **How Well? (Performance)**
  - Matched Removal
  - 34 – 38% Defectivity Improvement
  - Stable/Sustainable Solids Concentration
  - No Accumulation of Impurities
GREEN AND EFFICIENT

HIGHQ-FACTORY GMBH

Thank you for your attention!

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