Slurry Pump Affects on Distribution and Point of Use CMP Systems

2/16/06

Levitronix User’s Group Presentation

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Project Goals

- A Comparison Study Between Two Slurry Distribution Pump Types
  - Slurry Particle Performance in Bulk Supply System
    - Bellows Pump Performance
    - Levitronix® BPS3 Performance

- Point of Use Slurry Pump Systems
  - Peristaltic Pumps vs. Levitronix® BPS1 System
    - Oxide Novellus 200mm Momentum® CMP
    - Copper AMAT MirraMesa® 200mm CMP
Agenda

- Part 1 – Distribution Pump Systems
  - Bellows Pump Distribution Configuration
  - Levitronix Distribution Configuration
  - Large Particle Data
  - Slurry Delivery System Particle Data
  - Filter Efficiency
Part 2 – Point of Use Pump Systems

- Peristaltic Pumps vs. BPS1
- Pressure Affects on Peristaltic Pumps

Novellus Momentum® Study
  - Peristaltic Pump Linearity
  - Uniformity & MRR Curves
  - Discussion

AMAT MirraMesa® Study
  - Peristaltic Pump Linearity
  - Uniformity & MRR Curves
  - Discussion
Part 1

Distribution Pump Systems
Bellows Pump Distribution Configuration

From Blending System

Slurry Distribution System

Recirculation

Bellows Pump

Polisher x
Point of Use Slurry Pumps

Polish Heads

Polisher 5
Polisher 4
Polisher 3
Polisher 2
Polisher 1

Loop Filtration System
Slurry Delivery System Large Particle Data

- Slurry Distribution Particle Performance

![Graph showing particle performance over time](image-url)
Slurry Delivery System Particle Data

- Slurry Distribution Particle Performance

**Large Particles, Oxide Slurry**

Shows slurry system cleans up after Levitonix® Pump Installation
Filter Efficiency

- Bellows Pump vs. Levitronix® BPS3

![Graph showing particle removal efficiency for Bellows Pump and Centrifugal pump vs. particle bin size (micron)].
Part 2

Point of Use Pump Systems
Peristaltic Pumps

- **Benefits**
  - Simple Design
  - Self Priming
  - Proven System

- **Disadvantages**
  - Flow Surging
  - Tubing Particles Shed Into Slurry Stream, Causing Wafer Scratches
  - High Maintenance
  - Requires Frequent Recalibrations
  - Output Flow Dependant on Input Pressure
  - Requires Expensive Consumable Pump Tubing
BPS1 Closed Loop Flow Control System

Benefits
- Increased Process Flow Rate Accuracy
  - Process Flow Rates Independent of Loop Filter Loading
  - Process Flow Rates Independent of Distribution Slurry Demand
- Constant Pressure
- Lower Maintenance
- Decreased Downtime
- Eliminates a Consumable Item
- Eliminates Tubing Particle Shedding Into Slurry Stream
- Increased Filter Lifetime

Disadvantages
- Increases System Complexity
- Not Self Priming
Peristaltic Pumps vs. BPS1

Peristaltic Pump System

Levitronix® Closed Loop Flow Control Pump System
Pressure Affects on Peristaltic Pumps

- Peristaltic Pump variability caused by pressure fluctuations
  - Flow rates change in response to supply pressure fluctuations
    - Filter Loading changes input pressure
    - System Loading caused by Slurry Demand

100mL Comparison

<table>
<thead>
<tr>
<th>Filter Type</th>
<th>Pressure Drop</th>
<th>Flow Rate Difference</th>
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<tbody>
<tr>
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Novellus Momentum®
Closed Loop Flow Control
Peristaltic Pump Linearity

- Commanded Flow Rate vs. Actual Flow Rate
  - 2-Point Calibrated Peristaltic Pump System
Uniformity & MRR Curves

- Peristaltic Pump Removal Rate / Uniformity Curves

![Graph showing Slurry Flow Rate vs. Removal Rate / NU for 10 Pad Conditioning Sweeps. The graph displays the removal rate and NU values across different flow rates. The average removal rate slope is mentioned as 100mL - 260 mL, 49A / min.]
Uniformity & MRR Curves

- BPS1 Pump Removal Rate / Uniformity Curves

Slurry Flow Rate vs. Removal Rate / NU
10 Pad Conditioning Sweeps

Average Removal Rate Slope
@ Range = 100 mL - 260 mL
19A / min

37.5 RR Difference
Peristaltic Pumps vs. BPS1

Oxide Removal Rate / Uniformity Curves

Uniformity Divergence
Under 80mL/min
Discussion – Uniformity Theory

- Slurry flow surging causes variable spatial distributions between the wafer surface, polish pad, and polish particles.
- Flow accuracies of both pump systems are accurate. The most significant difference is flow surging.
AMAT MirraMesa®
Closed Loop Flow Control
Peristaltic Pump Linearity

- Commanded Flow Rate vs. Actual Flow Rate
  - 7-Point Calibrated Peristaltic Pump System

![Graph: Commanded Flow Rate vs. Actual Flow Rate](image)
Uniformity & MRR Curves

- Copper Removal Rate / Uniformity Curves

Removal Rate Divergence Under 75 mL/min
Uniformity & MRR Curves

■ Barrier Removal Rate / Uniformity Curves

Uniformity Divergence under 100mL/min
Discussion – Uniformity / MRR Theory

- MRR and NU divergences occur at low slurry flow rates.
- Slurry flow rate is a major variable for removal rate.
- Below 80 mL/min, the peristaltic pump does not supply the process a constant slurry flow to keep the process stable.
- MRR and NU divergences are the result.
Conclusion

- Reduction of large particles in oxide slurry supply system can be achieved with the Levitronix® Pump.
- The BPS3 distribution pump tested reduced 800nm particles by 28 percent.
- Particles 1 micron and greater were reduced by 50% or better.
- Slurry filter efficiency improves with the Levitronix® pump.
- Levitronix® POU slurry delivery system eliminates flow surging caused by peristaltic pumps.
- Levitronix® BPS1 POU pumps show an improvement in MRR and NU flow rates below 80 mL/min.
Acknowledgements

- Benno Milmore, Process Engineer, LSI Logic® Manufacturing Services, Inc.
- Reto Schoeb, CEO, Levitronix®
- Rob Stitz, Controls Engineer, Levitronix®.
- Gary Rawson, Technologies North America.