Problem Statement

Slurries are expensive and reducing their flow rate is among the top objectives of any CMP module leader and fab manager.

Slurries vary in chemical and physical properties and they rely on different mechanisms for removal.

Therefore, a simple reduction in slurry flow without understanding the nature of the slurry, and without fundamentally changing the method of slurry dispense, can cause adverse effects such as:

- Lower RR
- Higher WIWRRNU
- Higher wafer-level polishing defects
- Slower displacement of rinse water from the pad surface

Each IC fab employs different processes and different sets of consumables (i.e. slurry, pad and conditioning discs). Therefore no universal technological solution exists for slurry flow rate reduction.
The Araca Slurry Injection System (SIS)

Araca has developed, and is selling, novel slurry injection systems for:

- Applied Materials Mirra® and Reflexion LK®
- Ebara EPO-222®
- Ebara F-REX200® series
- Ebara F-REX300® series
- SpeedFam IPEC 372 and 472

Compared with standard slurry application methods (i.e. dispensing the slurry near the center of the pad or through a plurality of holes sprayed over the pad radius), SIS provides:

- Higher material removal rate at the same slurry flow rate
- Same material removal rate at a lower slurry flow rate
- Equivalent or lower wafer-level polishing defects

In this presentation, we highlight our latest results on various polishers equipped with SIS technology.
SIS Principle of Operation

Injector bottom is made of PEEK. It contacts the pad.

The air interface is eliminated.

Fresh slurry is applied between the injector bottom and the pad:
- Thin fluid layer
- Less micro-lubrication

SIS can be configured to inject at multiple points to accommodate pad grooving differences.

SIS is flexible and it conforms to the pad as the pad wears over time.

SIS squeegees the pad and significantly reduces the chances of the following to re-enter the pad-wafer interface:
- Pad rinse water
- Used slurry
- Reaction products
- Foam
- Pad debris and particles
Our ‘Number 1’ goal is to make SIS as simple, and as non-intrusive, as possible so as to minimize barriers to entry into IC fabs and provide users with 25 to 55 percent saving in the slurry (or 5 to 15 percent increase in RR).

SIS is a completely ‘passive’ system that is easily integrated with an HVM polisher:

- Uses existing slurry plumbing
- Does not require the removal of the slurry applicator or injector that comes with the polisher
- Requires no process changes except slurry flow rate or polish time reduction
- Can be installed and removed rapidly (in less than 2 minutes) for pad changes
- Requires no power
- Does not require changes in the polisher software
- Does not require physical modification of the polisher
- Polisher interlocks do not have to be disabled
SIS Installed on AMAT Reflexion LK® Polisher

Quick disconnect and three hand screws for pad change.
SIS Tested on AMAT Reflexion LK® Polisher

Polish Time and Pressure: 1 minute at 1.5 PSI

Platen Velocity: 98 RPM

Wafers: Blanket 300 mm TEOS and copper

Pad: VP3500 concentrically grooved pad

Flow Rate:

• 110, 150 and 180 ml per minute
• Standard slurry applicator: 1 wafer processed at each flow rate
• SIS: 1 wafer processed at each flow rate
Results – SIS on AMAT Reflexion LK® Polisher
TEOS Polishing

25% Slurry Flow Rate Reduction
Results – SIS on AMAT Reflexion LK® Polisher
Copper Polishing

36% Slurry Flow Rate Reduction
Note: The upward trend (in some cases) was also seen when the standard center application method was used.
SIS for EBARA F-REX200® Polisher

One hand-screw to remove injector

Pad

Existing Device

Wafer

Existing Bracket
SIS Tested on EBARA F-REX200® Polisher

Polish Time and Pressure: 1 minute at 3 PSI

Platen Velocity: 40 RPM

Wafers: Blanket 200 mm TEOS

Pad: IC1000 K-groove pad

Flow Rate:

- 100, 150 and 200 ml per minute
- Standard slurry applicator: 4 wafers processed at each flow rate
- SIS: 4 wafers processed at each flow rate
Results – SIS on EBARA F-REX200® Polisher

50% Slurry Flow Rate Reduction

Slurry Flow Rate (ml/min)

Removal Rate (A/min)

Normalized Defect Count

Standard Applicator

SIS

LPD

Area Defects
SIS for EBARA F-REX300® Polisher
SIS Tested on EBARA F-REX300® Polisher

Polish Time and Pressure: 1 minute at 2 PSI

Platen Velocity: 80 RPM

Wafers: Blanket 300 mm TEOS

Pad: VP5000 K-groove pad

Flow Rate:

- 100, 150 and 200 ml per minute
- Standard slurry applicator: 1 wafer processed at each flow rate
- SIS: 1 wafer processed at each flow rate
Results – SIS on EBARA F-REX300® Polisher

![Graph showing 34% Slurry Flow Rate Reduction](image-url)
SIS Installed on EBARA EPO-222® Polisher

Only one thumb screw is needed to install or remove the injector
SIS Tested on EBARA EPO-222® Polisher

Polish Time and Pressure: 1 minute at 9.4 PSI

Platen Velocity: 71 RPM

Wafers: Blanket 150 mm TEOS

Pad:

• K-grooved PU pad

Flow Rate:

• 70, 95 and 120 ml per minute
• Standard slurry applicator: 2 wafers processed at each flow rate
• SIS: 2 wafers processed at each flow rate
Results – SIS on EBARA EPO-222® Polisher

![Graph showing removal rate vs. slurry flow rate with a 36% slurry flow rate reduction.]
The SIS ‘Kit’

SIS is sold to customers as a kit that can be installed, used and uninstalled with maximum ease and efficiency.

Each ‘kit’ is comprised of 1 MOUNT and 3 INJECTOR units.

The MOUNT (which also includes the rods that connect it to the INJECTOR) is assumed to have a long life (i.e. more than 4 years).

The estimated life of each INJECTOR will vary (i.e. 3 or more months) depending on the consumables set and the polishing recipe.

Once it has reached EOL, the INJECTOR should be returned to Araca for complete replacement of critical parts, refurbishing of the entire unit, recertification and return at a nominal cost.

SIS is priced such that fabs can attain ROIs ranging from 4 to 8 months depending on the particulars of the process and consumables.
The SIS ‘Kit’ for AMAT Reflexion LK® Polisher

MOUNT
(1 Unit)

INJECTOR
(3 Units)
The SIS ‘Kit’ for EBARA F-REX200® Polisher

MOUNT (1 Unit)

injector (3 Units)
The SIS ‘Kit’ for EBARA EPO-222® Polisher

MOUNT (1 Unit)

INJECTOR (3 Units)
Beta Testing of the SIS

Steps involved in a typical beta test of the SIS:

- NDA signed between Araca and enduser.
- Other testing agreements signed by all stakeholders.
- Consumables and polishing process recipe(s) obtained from the enduser.
- Polisher inspected at the enduser’s site to ensure it can accommodate the current SIS mounting design.
- Polishing tests performed at Araca using the enduser’s consumables and polishing recipes to ensure good performance and to minimize risk to all parties.
- Araca to prepare technical report and share it with all stakeholders.
- Araca to install and assist in testing the SIS at the enduser’s fab as per testing signed agreement (this should take 2 days to complete).
- Decision made with endusers as to next technical, commercial, sourcing and HVM fab support steps.
SIS is designed to significantly reduce slurry flow rate without adversely impacting RR. Wafer-level defects are typically comparable or lower than those observed with the Process of Record (POR) flow rate.

Alternatively, SIS may be used to increase RR at the POR slurry flow rate.

SIS units can be added to existing polisher hardware in the most non-intrusive manner and be removed in less than 2 minutes during HVM pad changes.

To mitigate risks, SIS units will be tailored to a specific customer’s process and tested at Araca’s applications lab to determine its COO reduction potential.

Validation of performance and COO reduction will occur on the customer’s polishing tool during a 2-day on-site beta test.

SIS is priced to yield ROIs ranging from 4 to 8 months depending on the particulars of the process and consumables.

Compared to POR, typical slurry savings of 25 to 55 percent have been observed on all polishers types and models tested.
Thank You!