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## Bertrand Loy, COO, Succeeds Gideon Argov as CEO of Entegris

Bertrand Loy has succeeded Gideon Argov as president and CEO as part of a management succession and transition plan, effective November 27, 2012. Bertrand is a 17-year veteran with Entegris and its predecessor companies (Millipore and Mykrolis), and most recently served in the capacity of Chief Operating Officer for Entegris. Bertrand Loy was also elected to the Entegris Board of Directors as part of this transition.



Paul Olson, Entegris' chairman of the board, said "The board has been developing a robust succession process with Gideon and Bertrand over the past two years. Bertrand is the perfect choice to lead Entegris going forward. He brings a keen intellect, excellent financial and operating skills, a global mindset, industry recognition, and a proven track record over the course of his 17-year career serving in senior financial and operating executive roles for Entegris

and its predecessor company, Mykrolis. On behalf of the board, I want to thank Gideon for his eight years of insightful leadership and for creating an excellent foundation on which to build for Entegris."

Mr. Argov said, "Entegris is an exceptional company and it has been an honor and privilege to lead it through a period of transformation change. With the company on a solid financial footing and performing well, the time is right to make this transition. I leave the Company in good hands to continue to grow and extend its market leadership."

Mr. Loy said, "I am excited to be named as the next chief executive officer of Entegris. Together with Gideon and the global Entegris teams, we have built a highly successful platform focused on helping leading technology companies improve their yields and advance their process technologies. I look forward to leading Entegris into a very promising future."

>> To view the Entegris corporate factsheet, click [here](#)

## Entegris to Renew the Collaboration Research Project with CEA/Leti on Cross Molecular Contamination

Advanced technology nodes are increasingly sensitive to molecular contamination. In particular, airborne molecular contaminations as well as the cross contamination issues emerging from the interaction between the clean-room environment, the process tool mini-environment, the container-wafer system as well as the pod-mask system need to be addressed.

The original two-year project carried out at the CEA/Leti facility in Grenoble, France will

be reviewed for the next 2 years. Entegris will pursue the study by providing polymer materials and products based on its deep knowledge of material science and micro-environment control.

>> Results of this project will be published in Zero Defects, so stay tuned!

# Process Stability

## Advanced Filtration Solutions for Front-End of the Line Wet Cleaning Applications

By Dr. Günter Haas - Entegris Europe

The present article reviews Entegris' recent developments in filtration technology for advanced Front-End of the Line (FEOL) processes, like SPM<sup>(1)</sup>, SC1<sup>(2)</sup>, SC2<sup>(3)</sup>, DHF<sup>(4)</sup> or BOE<sup>(5)</sup>, as well as purification technologies for critical rinses.

Wet cleaning and wet etch processes are some of the most frequent process steps in the semiconductor device manufacturing cycle, and can have a determining impact on manufacturing yield, and device performance. Systematically a particle filter has to be used to remove defect generating particles from the process fluid.

### Entegris Filter Offering for Aggressive Media

For aggressive media like SPM, SC1 or SC2, i.e. concentrated acids, those containing strong oxidisers or processes run at high temperatures, the only viable option with acceptable lifetime and performance for advanced processes are filters manufactured out of fully fluorinated polymers, e.g. PFA, with a non-dewetting Teflon® PTFE membrane.

Toronto 15 nm filters are the filters with the highest retention currently available for FEOL cleans, enabling 22 nm and beyond technology nodes.

### Entegris Filter Offering for Mild Media

For relatively mild media like DHF and BOE alternative membrane and construction materials may be utilised and provide high particle performance at lower cost.

### Intercept® Filters

Intercept HPM 10 nm filters are the highest performance solution available for these applications.

Intercept HPM filters offers:

- highest retention,
- highest flow rate and cleanliness of any low cost (non-Teflon) product on the market.

Intercept HPM 10 nm filters provide 10 nm filtration and excellent flow rate performance with Entegris' unique asymmetric UPE membrane.

### Entegris Filter Offering for Ultrapure Water Rinses

Ultrapure water rinses (UPW) following critical cleans can contaminate a clean wafer surface from dissolved contamination, notably metallic contamination, if the purity of the rinse water is not controlled to highest levels.

### Protego® Filters

Entegris' Protego Plus LTX 20 nm purifiers/filters can reduce metal and particle related defects and improve electric performance, yield and process stability by removing :

- sub-ppt amounts of dissolved metallic contamination from UPW and solvents with high throughput and large capacity,
- particular contamination of 20 nm.

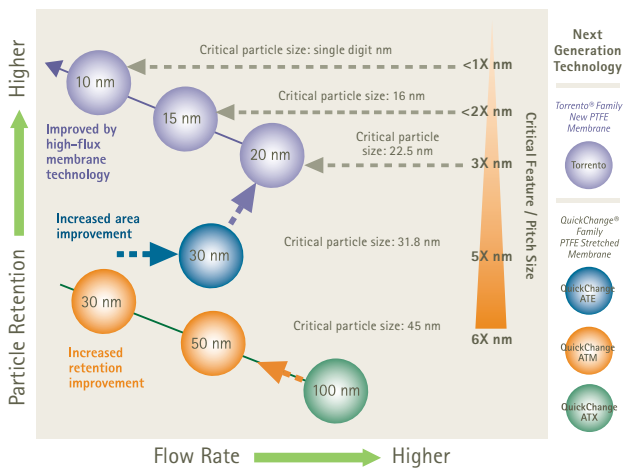
>> Our extensive product offering and application experience can contribute to answer your cost productivity and process performance challenges.



Entegris' Toronto filters are available in a wide range of configurations to fit flow rate and tool requirements.



Intercept Plus HPM Filters



### Filter performance guide

### QuickChange® Filters

Entegris' QuickChange filters with their proprietary non-dewetting membrane technology have been the industry standard for these applications for more than a decade, available in retention rating down to 30 nm, providing low Cost of Ownership (CoO) with reduced wafer defectivity and improved process stability.

### Toronto® Filters

Toronto high performance, all Teflon filter solutions are available in 20 and 15 nm retention ratings. With their novel high flow membrane technology these filters provide radically higher flow rate than the past filters.

The Toronto ATE 20 nm filters allow **effective filtration of 20 nm particles, yet with the flow rate of the best 50 nm filters.**

<sup>(1)</sup> Sulfuric Peroxide Mix, a mixture of sulphuric acid and hydrogen peroxide

<sup>(2)</sup> Standard Clean 1, a mixture of hydrogen peroxide, ammonium hydroxide and water.

<sup>(3)</sup> Standard Clean 2, a mixture of hydrogen peroxide, hydrochloric acid and water.

<sup>(4)</sup> Dilute hydrofluoric acid.

<sup>(5)</sup> Buffered Oxide Etch, a mixture of ammonium fluoride, hydrofluoric acid and water.

# Overall Equipment Efficiency

## New Filtration Control Method of IntelliGen® Mini

By Traci Batchelder- Entegris Inc.

The operation of the IntelliGen® Mini (Mini) has been evolving to provide our customers the best possible performance. This article presents the newest advance pump software enables faster priming and better filtration performance.

### Two-stage Technology

The Mini is based upon an operating principle famed as two-stage technology ( Fig. 1). Key feature is that the filter is physically located between two chemical stages; this allows chemical filtration to be controlled independently of dispense.

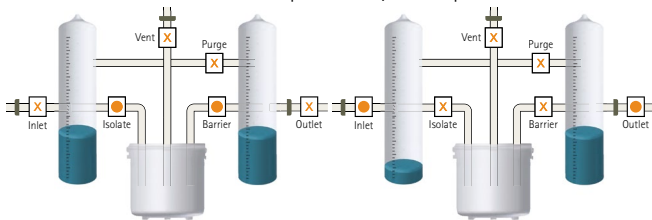


Fig. 1: Two-stage technology image

### New Filtration Control Concept

The Mini performs closed-loop pressure control during filtration. In the new filtration method, the second-stage motor is responsible to maintain the downstream pressure, while the first-stage motor advances to supply fluid at the user-programmed filtration rate.

| Pump Stage                    | Standard Filtration Control Method   | NEW Filtration Control Method  |
|-------------------------------|--|--|
| First-stage motor (Fill)      | Advances at the rate required to achieve and maintain the filtration pressure setpoint | Advances at the filtration rate setpoint                                   |
| Second-stage motor (Dispense) | Retracts at the filtration rate setpoint   | Retracts at the rate required to maintain the filtration pressure setpoint |

### Summary of the roles of the pump stages

### Advantages of the New Method of Filtration Control

- ▶ Faster filter priming
  - Eliminates the risk of an aborted priming due to the selection of a high filtration rate
  - Allows the use of aggressive rates allowing priming to complete sooner
- ▶ Provides a wider range of good defect performance, without having to change the filter retention rating in use

### Experiment

A Mini pump, linked to a Rion® KS-41 particle counter and syringe sampler were employed in the testing. The chemical used was a low viscosity BARC, and the filter chosen was an Impact® 2 3 nm asymmetric UPE.

### Filtration Performance Testing

For each test, the pump and particle counter were fully plumbed with chemical and the system was allowed to run with a 5 nm asy UPE to reach a low baseline level. Dispenses were stopped, and a new filter was installed. A priming sequence was started, after

which the pump performed dispenses to the particle counter until baseline steady state was once again achieved.

- ▶ Fig. 2 shows the priming sequence used for all filtration method testing with same priming sequence. However, faster filtration rates (3 mL/sec) could be used when the new filtration control method was enabled, which allowed the priming sequence to run 10% faster than with the standard filtration control method, where filtration rate was limited to 0.5 mL/sec for step 1, 1 mL/sec for step 2 and 1.5 mL/sec for steps 3 - 7 in order to eliminate the risk of an aborted priming.

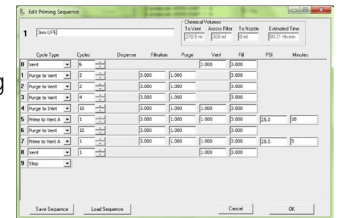


Fig. 2. Priming sequence screen shot

- ▶ After the first 3 nm asy UPE had achieved baseline using the current method with a filtration rate of 0.5 mL/sec and a filtration pressure of 4 psi, a matrix of experiments were performed that changed filtration conditions in a range from 2 to 8 psi and 0.1 to 3 mL/sec. Thirty dispenses were performed at each condition, and downstream particle were measured. The contour plots in Fig. 4 - 5 are based upon the last 20 of each set of 30 dispenses at each condition. The particle data was analyzed using Minitab® with an unique data processing.

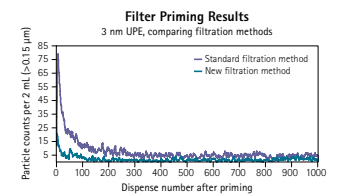


Fig. 3. Particle decreasing curves comparison of current & new filtration methods

- ▶ Fig. 3 - 5 shows the effect on particle results after filter change with the different filtration methods. The darkest blue area in the center of Fig. 5 shows not only particle performance of >0.5 particles per 2 mL, but overall, the total region of acceptable particle performance (< 2 particles per 2 mL) is much wider, allowing the use of faster filtration rate.

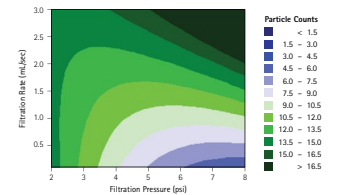


Fig. 4. Contour plot of particle performance using current filtration method

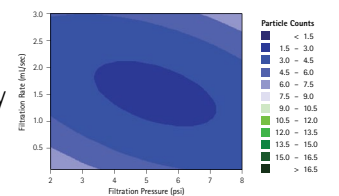


Fig. 5. Contour plot of particle performance using new filtration method

### Conclusion

New filtration control method is available for use with the IntelliGen Mini pump. This new method has the ability to decrease filter priming time and improve the defect performance without changes to the filter retention rating in use. These benefits can be realized by a simple change in the pump operating software, and can be enabled without changes to pump hardware or current filter in use.

# Cost Reduction

## New HWS300 Smartstack® Offers a Lower Price Coupled With Exceptional Performance

By Doug Moser - Entegris Inc.

Over the past few years, many customers have expressed the need for a reusable, lower cost "Injection Molded" 300 mm Horizontal Wafer Shippers (HWS).

Advancements in wafer fab and chip assembly technologies have rendered obsolete many finished wafer packaging systems used to transport and ship delicate wafers. These challenges must be addressed in a robust shipper to keep yield rates high and increase productivity in both fab and assembly operations.

Entegris' 1st generation HWS300 is outsourced due to its blow molded construction. Our next generation HWS300 is injection molded at Entegris' manufacturing facilities

### Key Advantages of the New HWS300 Smartstack

The latest HWS300 is engineered to provide a cost effective, safe, clean, and compact environment for safely storing and shipping 300 mm wafers. The molded HWS was developed in conjunction with equipment manufacturers and customers and has taken its design queues from the successful HWS150/200 products.

| Features   | Benefits   |
|--|--|
| Less weight - Injection molded vs. current blow molded product | The new product weighs ~2.3 lbs (~1 kg) vs. ~4.2 lbs (~1.9 kg) for the 1st generation HWS300.  |
| Improved design  | Latches similar in design to the current HWS150/200 (Operators experienced difficulty in the past locking/unlocking the latches on current HWS300) |
| Material - constructed   | Using the current material of record helping to ease customer qualifications   |
| Improved lead-time   | 4-5 weeks vs. current product lead-time of 11 weeks  |
| Improved quality control                                       | Manufactured by Entegris   |
| Competitive price  | Reduced list price by 55%  |



Blow Molded HWS 300 mm



Injection Molded HWS 300 mm

### Performance Testing

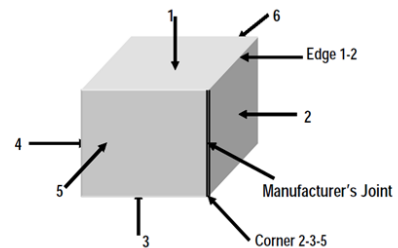
Drop testing was performed based on the International Safe Transit Associations Project 2A (ISTA 2A) via an outside ISTA certified laboratory. The purpose in testing was to complete an Entegris internal new product qualification as well as meet a customer

imposed requirement to fully validate product performance by showing compliance with the ISTA-2A procedure at an ISTA certified laboratory. Testing was performed using newly developed single-pack secondary packaging, using standard thickness wafers, closed-cell pink foam (CCPF), and Tyvek® separators at 3 atmospheric preconditioning scenarios (ambient: 23°C, cold: -29°C, and tropical-desert: 38°C/60°C).

### Testing Conditions

The testing included exposure to the following conditions in the order given:

- 1) Atmospheric preconditioning
- 2) Compression
- 3) Random vibration
- 4) Free Fall Drop (10 drops from 38")
  - Corner drop (2-3-5 corner)
  - Shortest edge from the corner
  - Medium edge from the corner
  - Longest edge from the corner
  - Smallest face of box
  - Opposite smallest face of box
  - Medium face of box
  - Opposite medium face of box
  - Largest face of box
  - Opposite largest face of box
  - Tested at ambient lab conditions



### 5) Random vibration

Following exposure to all 5 conditions, each HWS sample was removed from its secondary packaging, visually inspected for damage to the HWS product, and finally opened to complete a visual inspection of the wafers for damage.

The 300 mm HWS with the new single pack secondary packaging design rendered a passing result for all configurations and atmospheric preconditioning scenarios.

## Study of Frictional Forces Generated by Novel PCMP Cleaning Brush Nodule Geometries during PCMP Cleaning

By Chintan Patel and Bradley Wood - Entegris Inc.

One of the greatest challenges facing post-chemical planarization cleaning is efficient removal of particles left on wafer surface after polishing. In an effort to improve the cleaning efficiency of post-CMP brushes, steps need to be taken beyond making the brush cleaner at the point of manufacture or the point of use. A brush is needed that also cleans more effectively.

In order to make a brush that cleans more effectively, it is necessary to study new geometries of brush nodules that can more completely clean the wafer surface as compared to the standard nodule designs.

These new nodule geometries will be examined using different cleaning parameters (brush rotational speed, normal force) to demonstrate an optimal brush cleaning regime. Each different nodule geometry will be compared to examine how nodules differences can impact the brush friction and therefore the cleaning efficiency of a brush in a given regime.

### Wafer Cleaning Challenges and Contributing Factors

#### Post-CMP Cleaning Challenges

- Improved whole wafer cleaning
  - Slurry/BTA residue cleaning
  - Organic particles
  - Foreign material
- Scratching and induced-defect reduction
  - Additional metal layers in smaller nodes
  - Smaller line widths result in small defect size tolerance

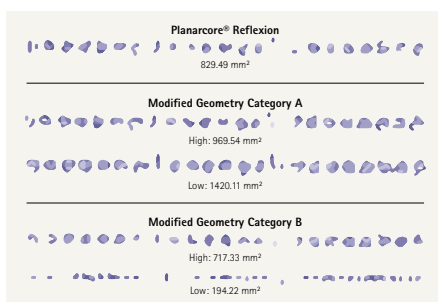
Multiple factors need to be considered when looking at wafer cleaning. Among these are:

- Brush contact area
- Friction of the brush as it contacts the wafer
- Force of the brush contacting the surface at a given gapping distance

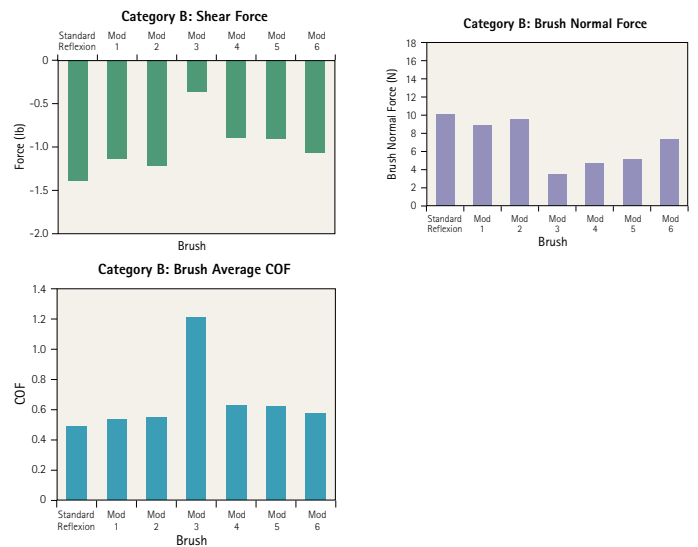
A new way to address these factors would be to alter the brush geometry.

#### Observed Brush Contact Area per Brush Compression Distance: 2 mm

- Images are taken when brush is static
- Numbers generated from average contact while brush is rotating

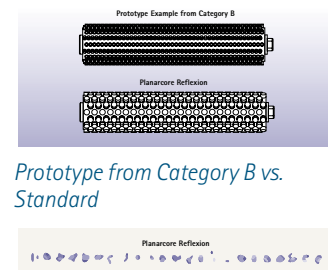


#### Shear Force, Normal Force Compression and Coefficient of Friction Compression Distance: 2 mm

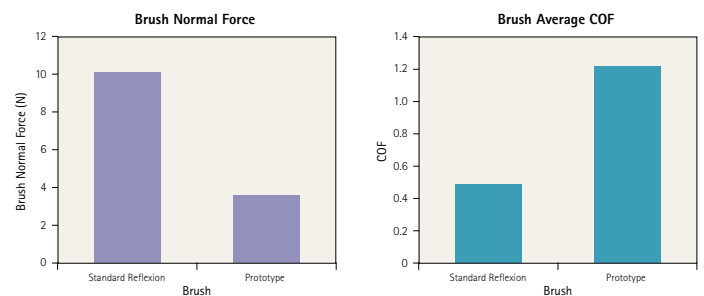


#### Case Study

##### Prototype Model vs. Standard Compression Distance: 2 mm



Prototype from Category B vs. Standard



#### Summary

- Tribological properties can be turned by adjusting certain aspects of the brush geometry.
- Adjustment of the brush geometry can be used to enhance brush on-wafer contact forces to overcome particle adhesion and achieve improved cleaning
- Improved cleaning leads to enhanced defect reduction and better overall wafer yield

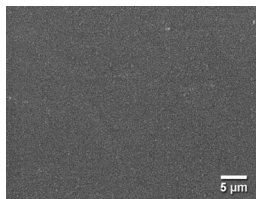
# Product Highlight

## UltraC™ Diamond Coating: Minimize Formation of Wear Debris

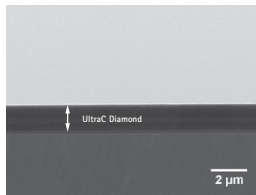
Entegris' UltraC™ Diamond coating is a diamondlike carbon (DLC) coating with **very high hardness, high lubricity and extremely smooth surface**. UltraC Diamond is deposited using a low-temperature (<150°C) proprietary Plasma Enhanced Chemical Vapor Deposition (PECVD) process and can be deposited on virtually all vacuum compatible substrates, including polymers. The coatings can be deposited over large areas, uniformly and with a high degree of conformality.

▶ UltraC Diamond can **significantly minimize or eliminate the formation of macro and submicroscopic wear debris**. UltraC Diamond is increasingly specified for a wide range of precision applications in demanding environments encompassing semiconductor wafer processing and other anti-friction and wear applications.

With the new European coating facility



SEM image - Coating Surface Morphology



SEM image - Coating Cross-section

in France, Entegris can now apply this coating on a worldwide level with faster response and service.

### Key Features

- Extremely wear resistant
- Super hard
- Ultra low friction
- Corrosion resistant
- Stops the formation of macro and submicroscopic wear debris

### Specifications

|                          |                                       |   |
|--------------------------|---------------------------------------|---|
| Substrate:               | Compatibility                         | Metals, ceramics (AlN, Al <sub>2</sub> O <sub>3</sub> , quartz, YSZ, Si, graphite, etc.), many polymers and anodized metals |
|                          | Size                                  | Up to 91 cm (36")   |
|                          | Geometry                              | Any shape, including complex geometries   |
| Structure:               | Dense, amorphous, micro-conformal DLC |   |
|                          | Temperature:                          | Deposition <150°C (302°F)   |
| Use                      | 400°C (752°F)                         |   |
|                          | Coating thickness:                    | 1–10 µm   |
| Electrical resistivity:  | 10 <sup>5</sup> –10 <sup>7</sup> Ω-cm |   |
| Coefficient of friction: | 0.04 – 0.08                           |   |
| Hardness:                | 3000 HV (24 GPa)                      |   |
| Wear resistance:         | Excellent                             |   |
| Corrosion resistance:    | Resistant to most acids and alkalis   |   |

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