

CONTENTS

1. Entegris News

- Entegris to Actively Participate in 450 mm US and EU Consortia
- Entegris @ SEMICON® West

2. Process Stability

- Reduce Materials, Labor and Maintenance Costs with Entegris CR-288® Concentration Monitor

3. Yield Improvement

- Entegris Crucibles to Act as an 'Energy Efficient' Thermal Barrier

4. Innovation

- Cross Contamination from FOUPs to Wafers: A Complex Phenomenon
- New 200 mm Contactless HWS Offers Innovation Coupled with Increased Yields

6. Product Highlight

- Protego® Plus IPA Purifiers Provide Superior Metals and Particle Removal in the Most Demanding Technology Nodes

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Entegris to Actively Participate in 450 mm US and EU Consortia

As a part of our ongoing investment to support the semiconductor industry's transition to 450 mm, Entegris is actively engaged with leading 450 mm consortia.

- ▶ Our shipping and handling products for the safe, reliable transport and processing of 450 mm wafers were selected by the Global 450 mm Consortium (G450C).

The G450C is a public-private partnership program announced by New York Governor Andrew M. Cuomo in September 2011 to facilitate the 450 mm wafer size transition. It is spearheaded by CNSE in partnership with Intel, IBM, GlobalFoundries, Samsung and TSMC.



Entegris' comprehensive wafer handling solution selected by the G450C includes the 450 mm Multiple Application Carrier (MAC), 450 mm Front Opening Unified Pod (FOUP), 450 mm Single Wafer Shipper (SWS) and an innovative packaging system.

As part of its agreement with the G450C, Entegris has agreed to provide on-site services, allowing the G450C to fully leverage Entegris' industry recognized expertise in engineering wafer handling solutions, and ensuring G450C maximum efficiencies to accelerate the proliferation of 450 mm processes.

- ▶ Entegris with its French subsidiary Entegris Cleaning Process (ECP) will actively participate in the [European ENIAC JU E450EDL program](#). The project goal is to install a 450 mm Equipment Demo Line at Imec equipped with European systems, implementing first critical process modules and acquiring information on 450 mm wafer behavior. ECP will develop and qualify a cleaning process for 450 mm products, which will include wafer carrier inspections, cleaning, replacement and packaging in order to provide the user a "ready for use" product.



Entegris @ SEMICON® West

Entegris continued its focus on customer meetings at the W hotel, and partnered with



SEMI to host the **first annual Yield Breakfast Forum**. Moderated by VP of Marketing Wenge Yang and attended by 85 guests, the Yield Breakfast Forum featured speakers from Intel, KLA-Tencor, ATMI, LAM Research and Entegris.

Entegris was active in SEMICON West's technical programs, sponsoring TechXPOT sessions "Addressing Nanodefactivity" and "The 450 mm Transition Forum". CEO

Bertrand Loy was featured on the Executive Panel addressing "A Promising but Challenging Future", and Jennifer Braggin spoke at SEMATECH's session on Nanoparticle Defectivity.

SEMICON West attendance was up 15%, with 20% international visitors. Our thanks to everyone who was able to attend!



Cost Reduction

Reduce Materials, Labor and Maintenance Costs with Entegris CR-288[®] Concentration Monitor

By Entegris, Inc.

With the acquisition of Jetalon, Entegris expands its fluid sensing and control offering to improve customer's process control capability and manufacturing yield.

- ▶ Entegris CR-288 Concentration Monitor and 288-connect[®] software package delivers real-time information for point-of-use chemical/mixing blending, spiking and dilution without process intrusion or interruption.



CR-288 Concentration Monitor

The PC-based graphical user interface and LCD display integrate data collection, analysis and field calibration along with convenient, scalable data interface and acquisition options. The optical system calculates real-time concentration and temperature-compensated data, all to improve productivity.

CR-288 Benefits

- Implementing CR-288 **eliminates the need to grab samples for laboratory analysis**, thus saving slurry, labor, and the opportunity cost associated with time spent waiting for results.
- Data is available continuously, at sampling rates of 1.2 seconds.
- The high degree of accuracy, simplified calibration, and temperature corrections enable **greater process control**. The device itself has no impact on the solution being monitored.
- The flowcell footprint is only 3" x 2" x 4" and comes standard with fine-thread Flaretek[®], Super 300 Type Pillar[™] and Prime-Lock[®] end connections; other end connections available upon request.
- CR-288 has no moving parts. **Maintenance is minimal**.

Case Study: Hydrogen Peroxide in CMP Slurries

Hydrogen peroxide concentration impacts removal rate, consumables life time, and product yield. Hydrogen peroxide concentrations must be monitored in CMP slurries, especially for metal CMP, tungsten, and copper.

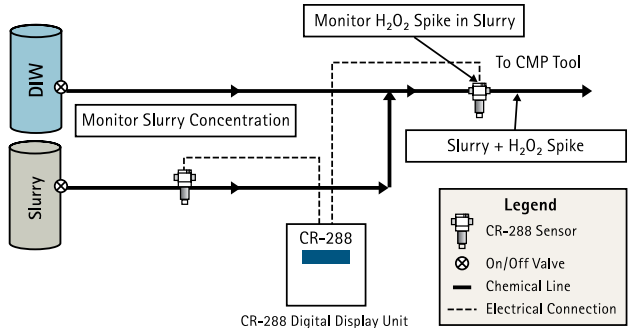
Maintaining the proper hydrogen peroxide reaction concentration:

- Increases product yield
- Increases wafer throughput
- Reduces particle contamination from CMP tool polishing pads, gaskets, O-rings, and other consumables, further increasing yield

Implementation Diagram

The following figure shows a typical configuration of two sensors and one DDU in a CMP slurry blending tool. Some implementations

use only one sensor after the peroxide is added to the slurry.



H₂O₂ spike in CMP Slurry

Cost Comparison vs. Auto-Titration

- ▶ Because it is an in-line automated test, CR-288 offers multiple benefits as seen before over other test methods, including auto-titration and laboratory analysis. Using CR-288 provides **significant cost savings in materials, labor, and maintenance compared with auto-titration**.

Auto-Titration/ Typical 200MM Wafer Fab	Data	Cost Per Month	Cost Per Year	CR-288 Comparison
Frequency of titrations	Every 8 hours			Real time monitoring
Time for complete titration	45 minutes			Real time Data point every 1.2 seconds
Frequency per day	3 times			Real time monitoring
Number of values per each titration	2			Real time monitoring
Amount of slurry used for each titration	1kg per titration value For each titration cycle, 2 values are taken. The result will be the average of these 2 values and each value will require 1kg of slurry at a cost of ~\$13 per kg.			0
Cost of slurry used per value	Cost \$13 per titration value (2 samples = \$26) x 3 per day = \$78 per day. Average 30 days.	~\$2,340	~\$28,080	0
Re-agent used for each titration	Re-agent is needed for chemical reaction to get titration. Re-agent is needed for each titration.	~\$4,300	~\$51,600	0
O-ring replacement	Change every 3 months @ \$10.00 per month	~\$10	~\$120	0
Probe	Change probe average of once every 6 mos.	~\$105.00	~\$1,260	0
Maintenance	Time to replace O-rings, probes, and other misc. items @ 1/2 day @ \$150 per hour (estimate)	~\$600	~\$7,200	Re-zero 1 per month 1 hour @ \$150
TOTAL		~\$7,355	~\$88,260	\$150

Yield Improvement

Entegris Crucibles to Act as an 'Energy Efficient' Thermal Barrier

By Entegris, Inc.

The Entegris graphite evaporation crucibles are designed to offer users improved evaporation performance over that obtainable in bare hearth mode. Crucibles physically protect the hearth, meaning less downtime for cleaning, less damage from destructive cleaning techniques, and less damage from accidents while handling.

Entegris Crucibles Advantages

Our graphite crucible acts as an "energy efficient" thermal barrier between the molten evaporant and the water cooled copper hearth.



Entegris Crucibles

This will allow either:

- an **increased deposition rate of up to 400% with the same power**;
- or **the same deposition using only 25% of the power**, when compared to evaporation from a bare hearth.

In some applications, the high power required to achieve an economical deposition rate can emit a form of radiation that can damage the devices on the wafers.

- ▶ Entegris crucibles allow for a much lower power setting while maintaining an acceptable deposition rate.

Entegris Crucibles Materials Benefits

Graphite

Entegris' POCO® facility manufactures graphite which is utilized in the production of evaporation crucibles.

The defining characteristics of Entegris graphite are its:

- inherent uniform micro-structure, providing consistent performance due to its high strength and purity;
- ability to withstand wide temperature regimes;
- small pore size.

These properties result in **longer life**, compatibility with a variety of melts and **high-yield depositions**. In combination, Entegris' POCO crucibles provide the **lowest cost of ownership**.

FABMATE®-BG Crucibles

FABMATE-BG crucibles offer the user:

- cleaner handling with reduced particle content in the melt;
- reduced wetting;
- longer crucible life.

DFP-1 graphite is densified, machined and purified and then given an amorphous carbon treatment. **This treatment is unique** because it does more than coat the surface. It also infiltrates and

locks onto the graphite. This treatment provides a **harder surface** with the porosity sealed to **reduce wetting and eliminate particles**.

Solutions to Common Problems

Melt Levels

The most common cause of crucible failures is overfilling. Overfilling can cause the melt to spill over the edge of the crucible. When a spill-over occurs, a thermal short is created between the crucible and the hearth. The resultant thermal stress causes the crucible to crack.

- ▶ For this reason a maximum melt level of 80% of the crucible capacity is recommended.

Ag	Be	Mo	SiO
Al	CdS	Na ² AlF ₆	SiO ₂
Al-Ge	CeO ₂	Ni _x Cr _x	Sn
Al-Si	Cr	Pb	Ta
As	Cu	Pd	Te
Au	Ga	Pt	Ti
B	Ge	Se	TiO

The Entegris graphite crucible is suitable for use with a large variety of materials.

Crucible Contact

Recommended Melt Materials

Another significant cause of crucible failures is cracking due to the improper seating of the crucible in the hearth. Out of round or chiseled hearths often create nonuniform mechanical stresses on the crucible walls.

- ▶ For the longest crucible life and for the most reproducible evaporation results, contact between the graphite crucible and the copper hearth should be restricted to the bottom of the hearth cavity. A circular graphite or copper shim is frequently used to achieve proper contact.

Handling

Improper crucible handling and storage also can be the source of crucible life problems.

- ▶ Crucibles should be handled with tongs, gloves or finger cots; never with bare hands or fingers. Used crucibles available for reuse should be stored in a dry, oxygen-free environment.

Aluminum Melts

Aluminum carbide formation affects the life of crucibles used for aluminum evaporation. The aluminum carbide forms a transparent, yellowish film on the surface of the aluminum. When the film covers the entire surface of the aluminum, the evaporation rate is reduced to near zero.

- ▶ The presence of this phenomenon is indicative of excessive crucible temperature. The power should be reduced to minimize the formation of aluminum carbide.

Innovation

Cross Contamination from FOUPs to Wafers: A Complex Phenomenon

By Paola Gonzalez Ph.D., Engineer Application Development | CEA-LETI Assignee - Entegris Europe

The molecular cross-contamination chain from FOUP (Front Opening Unified Pod) to wafers was clearly shown to lead to detrimental impacts in IC manufacturing, especially related to volatile acids. Among these species, HF cross contamination has been identified as a root cause of Cu, Al or poly-Si corrosion as well as TiFx crystal growth on TiN layers.

In the frame of the Entegris and CEA-Leti collaboration, comparative study of different FOUP platforms and polymers was carried out in order to quantify their ability to be contaminated by HF and to subsequently release this molecule. To reach this purpose, FOUPs were intentionally contaminated by HF vapours and then the subsequent desorption of HF concentrations was monitored inside FOUPs. The HF transfer and then the impact on wafers is forecasted as directly correlated to these outgassing results.

We experimentally addressed the contamination transfer from FOUP to wafers with a note on the unexpected behavior of PEI material, illustrating the complexity of the cross-contamination phenomena.

Experimental

FOUPs intentional contamination of HF, purge and outgassing stages

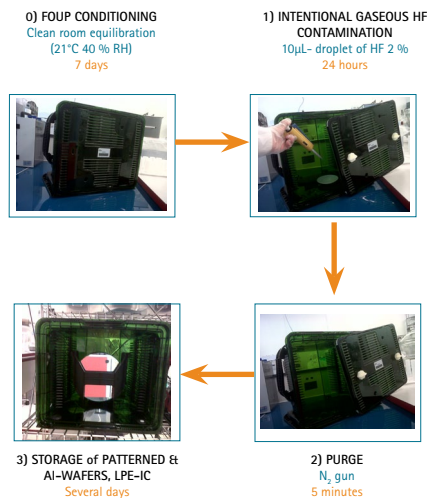
A 2% HF drop is placed into the FOUP during 24 hours, followed by a 5 min purge step and one week outgassing stage.

Quantification of contaminant transfer to wafer

AlCu wafers were exposed inside of a previously 24 h contaminated FOUPs and up to 12 days. The HF that outgassed and deposited on the wafers was collected.

Quantification of the HF amount in the FOUP polymers

After the above outgassing stage (7 days), HF amounts trapped in different FOUP polymers were sampled by repeated leachings of the FOUPs internal surfaces with UPW.



Results

The Entegris FOUPs composed of 6 different polymers were tested:

FOUP	Outgassing	HF deposition over AlCu wafer	Fluoride extraction
EBM/CNT	Low	Low	Low
PEI/CNT	Low	Low	Low
EBM	Medium	Medium	Medium
PC/CP	Medium	Medium	Medium
PEI	Low	Medium	Strong*
PC	Strong	Strong	Strong

EBM: Entegris Barrier Material
CNT: Carbon-nanotubes
PC: ultrapure polycarbonate

PC/CP: STAT-PRO® 500 carbon filled PC
PEI: polyetherimide

► EBM/CNT as well as PEI/CNT materials are performing better under HF contamination.

Results between outgassing, HF deposition on AlCu and fluoride extraction are consistent except for the PEI FOUP, demonstrating the complexity of the sorption phenomenon.

To explain this PEI polymer behavior, we hypothesize that in the PEI polymer, the basic groups present in the polymer chain promote H bond interactions between polymer and HF, thus limiting HF diffusion near the surface and resulting in no significant outgassing into the FOUP environment.

However, HF remains close to the surface and is available for outgassing without strong kinetic limitations due to diffusion from the core of the polymer to the surface as is the case for the other materials. This represents a quasi immediate available HF source for outgassing onto wafers which perturbs the equilibrium inside the FOUP leading to a relative rapid transfer to wafers.

Conclusion

Storage of AlCu wafers inside contaminated FOUPs demonstrated three very important facts:

1. The HF contamination from FOUP to AlCu surfaces occurs by molecular outgassing.
2. Low or no detectable outgassing does not guarantee a low transfer of contamination.
3. Cross contamination transfer is intimately linked to FOUP material properties and likely to the contaminant-polymer interactions.

Results showed three groups of FOUPs leading to high, medium and low HF transfer to AlCu-wafers. As a result, this demonstrates that **HF cross contamination from FOUP to wafer and the defectivity probability increase very significantly for the same contamination event depending on the FOUP materials.**

The potential risk can be ranked by growing order as **(EBM/CNT < PEI/CNT) << (EBM < PC/CP < PEI) << PC.**

Innovation

New 200 mm Contactless HWS Offers Innovation Coupled with Increased Yields

By Doug Moser, Product Manager | Microenvironments | Finished Wafer/Backend - Entegris, Inc.

With wafer thicknesses decreasing to 150 µm and below, manufacturing challenges arise. Ultra-thin wafers are less stable and more vulnerable to stresses, and the die can be prone to breaking and warping.

As technology is shifting to thinner and more sensitive wafers, many customers have expressed the need for a horizontal wafer shipper that enables them to:

- **ship and store their most sensitive lens/bumped wafers** (LED, 3D wafers, MEMS, and Taiko)
- **eliminate yield losses** caused by current TYVEK® inserts and foam cushions.

Shipping this type of sensitive wafer in a traditional HWS can damage the wafer causing rejection as a result of deformed bumps or scratches.

Applications such as advanced chip designs for 3D, 2.5D, SOC, MEMS, LED and power semiconductors is driving the need for smaller, higher performing and lower cost device configurations. These new options, especially 3D applications, are pushing demand for more thinned and ultra-thin semiconductor wafers. Power loss reduction and heat dissipation are also technical drivers of ultra-thin wafers.

These industry requirements have lead to the 200 mm contactless Horizontal Wafer Shipper designed by Entegris.



200 mm Horizontal Wafer Shipper - Contactless



Secondary Packaging

What are the advantages of using the new Entegris contactless solution?

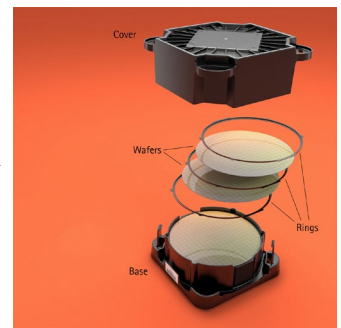
The new HWS200C addresses the need for solutions to ship lens/bumped wafers.

- **Less components** to order and inventory (TYVEK inserts/ pink foam cushions)
- **Improved shipping density** by eliminating the need for TYVEK and pink cushion inserts
- **Improved lead time:** 3-4 weeks vs. current 16 weeks for TYVEK and pink cushion inserts

- **Better quality control:** Quality issues with the current TYVEK and pink cushion inserts (dimensional issues, ionic contamination, wafer stains, etc.)
- **No chemical contamination** and mechanical surface contact on the wafer
- **Better shipping density** – ability to ship a full lot of 25 wafers.
- Designed for **auto-compatibility**.

Product overview

- ▶ Wafers are placed on rings
- ▶ Rings keep the wafers from contacting each other
- ▶ Design eliminates the need to use TYVEK separators and pink foam cushions
- ▶ Designed for automatic compatibility



Part numbers

HWS200C-101-61C02M	Shipper - includes 26 rings
HWR200-26PK-61C02M	26-pack replacement rings
HWS200C-1PK-KIT	1-pack kit - secondary packaging
HWS200C-1PK-CUSH	Cushion - secondary packaging
HWS200C-1PK-BOX	Box - secondary packaging

>> For more information about this brand new product, please contact your local Account Manager or Customer Service Support.

Product Highlight

Protego® Plus IPA Purifiers Provide Superior Metals and Particle Removal in the Most Demanding Technology Nodes

Integrated device manufacturers (IDMs) require the lowest parts-per-trillion (ppt) levels of metal ion and particle contamination in critical clean applications. Such processes call for the greatest degree of cleanliness, significantly fewer on-wafer defect counts and increased yields for sub-28 nm device manufacturing.

Protego Plus IPA advanced purifying filters provide superior metals and particle removal for critical clean IPA applications at the most demanding technology nodes. With a long lifetime and high metals removal of capability, you can experience:



- ▶ **Less downtime**
- ▶ **Fewer filter changouts**
- ▶ **Lower on-wafer defect counts**

Features and Benefits

Superior performance	Protego Plus IPA Purifiers are innovative in achieving maximum cleanliness and retention: <ul style="list-style-type: none">- Engineered for the highest possible metals removal capacity- In critical clean applications at the most advanced technology nodes, reliably removes metals and particles in IPA at the device level in point-of-use, single wafer spray processes- Despite increasingly stringent device specifications, meets the demands of rigorous production environments- Unlike existing IPA filters in the marketplace, causes far less particle shedding with low NVR, while also reducing metals in an all-in-one purifying filter
Cleanest device for advanced IPA processes	Lowest ppt levels of metal ion and particle contamination in critical clean applications: <ul style="list-style-type: none">- Meets strict cleanliness requirements for advanced technology nodes- Removes metallic contamination prior to the wafer surface- Reduces particles and defect counts- Increases production yields
High ion-exchange (IEX) capacity	Combining high IEX with clean PTFE membranes, Protego Plus IPA Purifiers efficiently capture traces of metal ions in IPA while reducing particles: <ul style="list-style-type: none">- Generates fewer filter changouts and less on-wafer defects- Reduces system downtime- Increases filter lifetime



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