ZERO DEFECTS
Europe Newsletter
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CEA-Leti and Entegris to study cross-molecular contamination between wafers and containers in semiconductor industry

Entegris and CEA-Leti have signed a two-year agreement to study the cross molecular contamination from/to wafer and/or containers for the semiconductor industry.

In the semiconductor market, the needs for increasing device performances has lead to new materials introduction while the needs to yield improvement has lead to new methodologies for wafer production.

Clearly, new materials imply new contaminations issues to manage and to avoid. On the other hand new methodologies in wafer production will lead to news types of container and new approaches of cleaning and managing them.

In particular, airborne molecular contaminations as well as the cross contamination issues emerging from the interaction between the clean-room environment, the process tool minienvironment, the container-wafer system as well as the pod-mask system need to be addressed. Therefore it will be very important to have the appropriate methodologies in order to understand the physics and chemistry behind the contamination mechanism.

This two-year project will be carried out at the CEA/LETI facility in Grenoble, France. CEA-Leti with its 8,000-m² R&D 200-300 mm pilot lines, used for advanced development at 32 nm node and below and its tight collaboration with key semiconductor manufacturers meets all the conditions to be able to perform contamination studies in realistic production conditions. Moreover, CEA-Leti will share his high level technical competences in the study of the contamination process together with the access to the Nanocharacterization Platform which can eventually provide complementary analytical techniques.

Entegris will provide different microenvironment platforms designed to protect critical materials from molecular contaminants as well as share its expertise in material science.

"*Advanced technology nodes are increasingly sensitive to molecular contamination. Leti can characterize the micro-environment and correlate it to the sensitivity of critical substrates and surfaces*," said Dr Jim Ohlsen, Entegris Director of Materials Characterization. "*Entegris will contribute to the project by providing polymer materials and products based on our deep knowledge of material science and micro-environment control*".

"*This project is aligned with our roadmaps on the development of new methodologies analysis related to the study of all aspects of contamination in the semiconductor production environment.*" said Narciso Gambacorti, CEA-Leti program manager. "*Leti will contribute with its knowhow on contamination analysis while Entegris will have the opportunity to test new polymers materials and new carriers designs in the Leti production-like environment*".

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Entegris
creating a material advantage

Lithography cost savings through resist reduction and monitoring program

By Jennifer Braggin, Brent Bjornberg – Entegris, Inc.
Terri Couteau, Scott Lindauer, Chris Stewart – Spansion, Inc.

The photolithography sector often has the greatest challenge in reaching yield and cost targets. This sector is always at the leading edge of technology and is often the first to adopt new materials, process integration strategies and equipment in order to drive manufacturing. Entegris Inc. has partnered with Spansion, Inc. to reduce resist usage on a common photoresist and also provide more robust monitoring to prevent scrap and rework.

This study evaluates the cost benefits of utilizing an advanced dispense system, such as the IntelliGen® Mini, made by Entegris, Inc., combined with an every-wafer-point-of-dispense-monitoring strategy.

Resist reduction program

When a technology and process become stable, process and equipment engineers are tasked with reducing costs. One way to reduce cost in the lithography sector is to reduce resist usage:

- choosing less expensive materials
- adding a solvent prewet
- **adjusting the process equipment to utilize fewer chemicals**

The IntelliGen Mini's unique two-stage technology design allows for the filtration and dispense functions to operate completely independently, allowing the end user to fine-tune the dispense process without worrying about the effect of filtration.

Once the process has been tuned to reduce resist waste, it is even more critical to ensure that dispenses are monitored. Several monitoring strategies are available for today's lithography sector:

- Macro inspections after coating
- Macro inspections after exposure
- Lithography metrology after exposure
- **In-line, point-of-use dispense monitoring**

The best method to find a coating issue in real time is to monitor at the point of dispense. If an issue is detected within the track, the wafer can be immediately reworked, saving time and cost of further processing. The IntelliGen Mini dispense system is unique in its ability to detect coating issues in real time. Dispense confirmation is a proprietary software solution that compares the current dispense to a defined golden reference.

The ultimate goal of this project was to reduce resist consumption on a commonly used resist. Figure 1 shows the step-down effort to reduce resist volume by initially making process and equipment improvements, and further reducing resist volumes by introducing the new dispense system.

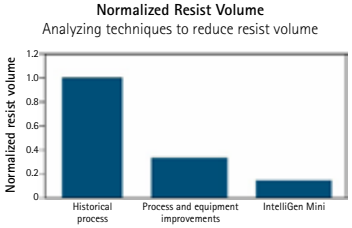


Fig. 1: Dispensed volume per wafer when testing new resist consumption reduction methods.

Every-wafer-monitoring strategy

The driver for an every-wafer-monitoring strategy with the new, low dispense volume was a particular excursion event at Spansion.

At final wafer sort, a "keyhole" pattern was seen on 25 wafers per quarter. The pattern showed passing die only in the center of the wafer, indicating intermittent coating issues with the wafers at the lithography step. Unfortunately, because these wafers were not caught in the lithography bay at the point of dispense, they were fully processed and the issue was not detected until final sort.

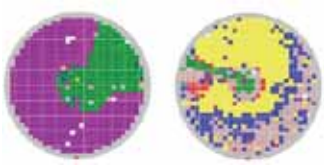


Fig. 2: Keyhole patterns detected at final wafer sort.

While 100% macro inspection was turned on initially in the fab, the inspection was not highly reliable and frequent escapes occurred. Once it was determined that dispense confirmation was robust enough to catch failures, the macro inspection was eliminated, saving processing time. This strategy has driven wafers failing from the "keyhole" pattern from 25 wafers per quarter to 6 wafers per quarter.

Efficiency gains and cost savings

Combining IntelliGen Mini features with the use of Entegris Network Platform Box, several efficiency gains were made. These gains include:

- Remotely accessing pump data from anywhere to look at the pump data any time there is a fail. This single reduction saved each Spansion engineer 30 minutes per day, specifically reducing the time required to walk to the fab and gown up to enter the cleanroom.
- Triggering filter changes through filter cycle data plotted to an SPC chart.
- Remotely controlling the pump to perform simple tasks, like additional filter venting, when necessary.
- Comparing the same resist process on different tracks.

Return on investment

In this study the authors were able to reduce dispensed volume by 83% by making changes to the process and equipment to create a repeatable, small volume dispense. This particular change on one dispense point could save $185,000 annually on resist.

➔ *Click on this link to view the video on this study*
Click on this link to view the complete paper
Contact: europe_region@entegris.com

Process Stability

Utilizing nano-fiber depth media for improved filtration performance in CMP applications

By Anthony Dennis , Product Manager and HJ Yang, Director, Applications Development - Entegris, Inc.

Filtration of CMP slurry used for polishing wafers in the IC manufacturing industry has been widely adopted to improve performance and increase yield. As the industry moves towards smaller feature sizes, tighter filters are needed to provide the same level of defect reduction. This paper introduces the benefits of utilizing nano-fibers in depth media filtration to obtain high retention of small particle sizes while maintaining excellent flow and lifetime characteristics.

Benefits of nanofiber media in filtration performance

Nano-fibers are small media fibers in the sub-micron range. The use of nano-fibers allows for smaller mean flow pores, while retaining very high porosity.

A *B* *SEM images*

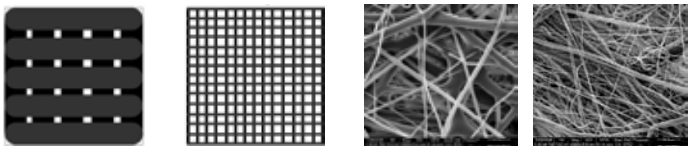


Figure A represents a 2-D filter with very large fibers used to create a tight pore structure. Figure B is a filter of similar pore size, but utilizing much smaller fibers. The smaller fibers allow for many more pores which greatly improves the flow performance, while maintaining the tight pore structure.

Conventional melt blown media

Nano-fiber media

When utilizing nano-fibers in filter construction it is extremely important that the filter is optimized so that the tight pore structure of the nano-fiber layer is protected. If not properly optimized the tight media could quickly plug and the performance benefit of nano-fibers would not be realized.

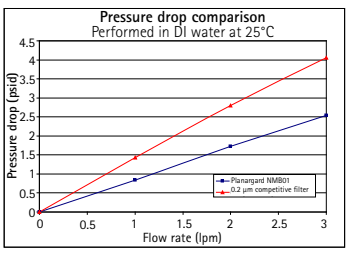
Experimental data

In general, the three most important characteristics of a filter are its pressure drop, its retention performance, and its lifetime. These characteristics indicate, respectively, how much the filter will impact the process flow, the size of unwanted particles the filter will be able to remove, and how often the process will need to be shut down to replace the filter.

Entegris has developed a new filter family, Planargard® NMB, utilizing nano-fiber media. Planargard NMB filters were used to compare the effectiveness of nano-fiber media in relation to other conventional filters available today; Entegris Planargard CL filters and other commercially available depth media filters of similar pore size.

Pressure drop

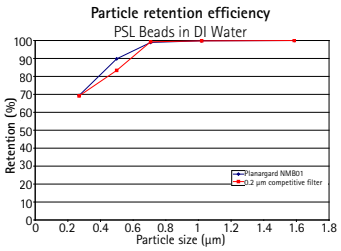
Pressure drop comparison of Planargard NMB



- The Planargard NMB01 filter with nano-fibers allows for 30% less resistance compared with the competitor 0.2 µm filter

Retention performance

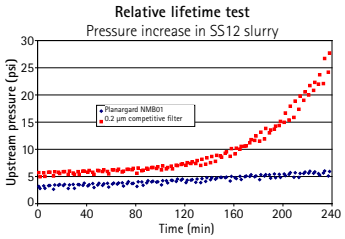
Particle retention performance of the Planargard NMB01 vs. commercially available 0.2 µm filter



- The graph shows about 10% increase in retention at the 0.5 µm sized particles

Relative filter lifetime

Graph illustrates the increase in upstream pressure as the filters plug with slurry

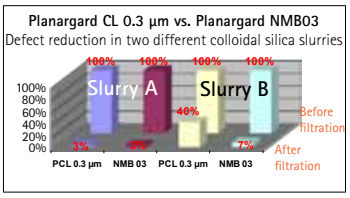


- Over the course of the test, the Planargard NMB01 has a much lower increase in pressure, resulting in a longer lifetime and lower CoO

Customer evaluation

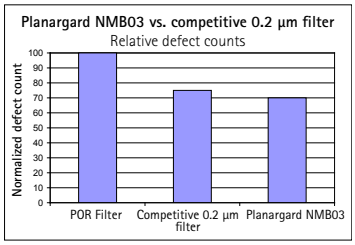
After the Planargard NMB filter passed a number of internal tests at Entegris, beta samples were given to some customers to evaluate in their applications.

Defect reduction observed at Customer A, with and without filtration. Customer A compared an Entegris Planargard CL 0.3 µm with the Planargard NMB03



- Results showed that in Slurry A the two filters had similar, excellent performance. In Slurry B the Planargard NMB03 was able to offer a 93% reduction in defectivity compared with 60% reduction for the current Planargard CL 0.3 µm filter.

Defect reduction at Customer B comparing a Planargard NMB03 and a commercially available 0.2 µm depth media filter



- The 0.2 µm filter showed a 25% decrease in defects compared with the POR filter and the NMB03 showed a 30% decrease in defectivity.

Combined with the improved flow performance, the 5% better defectivity performance of the NMB03 makes it a very promising filter.

Filters utilizing nano-fiber media offer low pressure drop, longer lifetime and improved retention over conventional depth media filters.

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Preparing for the move to 450 mm

By Bill Shaner, VP and GM, Microenvironments Business - Entegris, Inc.

The 450 mm question no longer is whether the semiconductor industry will move to the larger wafer size. Today, the question is: How soon? While the transition to 450 mm is expected to cost chip manufacturers and suppliers more than previous wafer-diameter shifts, most experts agree the investments will be offset by gains in productivity, cost effectiveness and product performance.

The exact debut date of 450 mm wafer production is far from certain. Still, many in the industry – including several large Integrated Device Makers (IDMs) and forward-looking suppliers – realize that it is a certainty and are preparing for the change and its multiple repercussions. Here are the top-line considerations:

450 mm manufacturing is a competitive necessity

Recognizing the need to follow Moore's law, several large (IDMs) have announced plans for 450 mm wafer manufacturing. While working to gain efficiencies in electronic device size and device-line widths, IDMs know that they must also employ larger wafers to gain significant economy-of-scale benefits, maximize chip yields and, ultimately, decrease production costs.

The change will create new wafer handling challenges

Larger wafers will require more advanced handling technology. Fortunately, manufacturers and suppliers can rely on the lessons learned from the last move to a larger wafer – from 200 mm to 300 mm – in developing advanced methods to transport and protect the larger wafers. Among the issues that come with 450 mm are:

Entegris 450 mm wafer carrier

- **Wafer fragility**. Increased wafer size means greater fragility. This is because the larger wafer is proportionally thinner and has a lower natural frequency than the 300 mm wafer. Therefore, its response to vibrations under normal shipping methods will be more severe. Careful handling with a robust secondary packaging system is crucial to help avoid breakage.
- **Wafer sag**. The proportionally thinner wafer also increases the potential for a 450 mm wafer to sag or "bow" more than a 300 mm wafer. This sag could create clearance issues that impact wafer-handling speeds and, therefore, a manufacturer's productivity. New MAC and FOUP designs must allow for dimensional accuracy and structural integrity of the carrier in light of the increased carrier size and wafer mass.
- **Increased weight**. A 450 mm wafer weighs three times as much as a 300 mm wafer. Multiply this by 25 – the average number of wafers transported in a single MAC or FOUP – add the additional weight of the larger MAC or FOUP itself, and the total mass of the 450 mm wafer carrier will be up to five times that of the 300 mm carrier. Because of the heavier payload, end users will need to rely more on automated handling of the 450 mm carriers within the plant.

Early adoption is key for suppliers

The move to 450 mm will require a significant investment in R&D, so there will likely be fewer 450 mm wafer manufacturers and customers than exist within the 300 mm market. The industry won't be ready to build a factory until all of the suppliers are in alignment, meaning all the players need to closely collaborate to ensure a smooth transition. The suppliers who come together early to make the necessary technologies available will gain a sustained business for the 30 years or more that these fabs will be in operation.

These companies also will likely gain market share around the globe. With fewer players in the 450 mm space, many of the regional and nationalistic supply chains of the past will consolidate into a more global portfolio of technology leaders. The sooner device makers align the global technical leaders, the sooner the supply chain will yield the technical and commercial results to enable successful commercialization of 450 mm.

Additionally, those suppliers aspiring for relevance in 450 mm can demonstrate their value through leadership in advanced 300 mm process development. Even if they are not currently in a position to leap into 450 mm, those who are driving sub 32 nm processes will be well-positioned for the future. As manufacturers begin production of chips at 22 nm and smaller, they will want to work with advanced suppliers who understand how this process node will work on various wafer sizes.

Funding could require creativity

Billions of dollars will be required to launch commercial 450 mm technology, and many suppliers aren't in the financial position to make the necessary investments on their own. However, many can seek financial support from local governments or other community players that stand to gain from the economic growth of new business and more jobs.

Case in point: Entegris recently opened an advanced technology manufacturing facility in Colorado Springs, Colo., to produce 450 mm wafer-handling products and Extreme Ultraviolet Light (EUV) reticle pods. Entegris worked with Colorado Springs Regional Economic Development Council (EDC), which provided a performance-based support package worth an estimated $1.3 million from the City of Colorado Springs, El Paso County and the state of Colorado.

Of course, such entities have finite funding, so suppliers who make the move to 450 mm first will be first in line for available financial support.

The move to 450 mm manufacturing is a certainty. For industry players who want to take advantage of the transition and the business opportunity it creates, now is the time to prepare their businesses.

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Yield Improvement

Entegris improves Fab productivity by RFID solution

By Jorgen Lundgren, Applications Engineer, Microenvironment - Entegris Europe

The tracking and tracing of semiconductor wafer production lots is becoming more and more important. This is directly related to fabrication productivity and, in some cases, yield.

The semiconductor industry uses various ID (identification) solutions provided by Entegris for tracking and tracing wafer production lots in a production environment. Identification options are mainly based on which products are to be identified.

Most common products such as wafer cassettes, wafer storage boxes and minienvironments (200 mm SMIF pods, 300 mm FOUP (Front Opening Unified Pod), FOSB (Front Opening Shipping Box) and reticle pods) use one of following ID solutions:

- Laser scribed
- Hot stamping
- Adhesive backed clean room barcode labels
- Encapsulated ceramic barcode plates
- PFA laminated PTFE barcode plates
- LF RFID (Low Frequency RFID - 134.2 KHz)
- Micro-tags
- Encapsulated alphanumeric colored ID tags
- Colored ID tags
- Colored card holders
- Segregation through product color

RFID

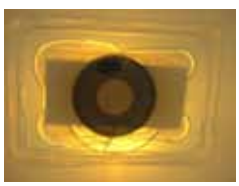
Radio Frequency Identification (RFID) is a contactless identification system where RFID tags and RFID readers transmit data to the MES (Manufacturing Execution System) and thereby enable the operator to know the exact location of each production lot. This results in improved automation and productivity.

Customer challenge

A large global European based customer requested our 200 mm PFA wafer process cassette to be integrated into their RFID Fab solution and be fitted with an RFID tag to enable 100% traceability within their production line.

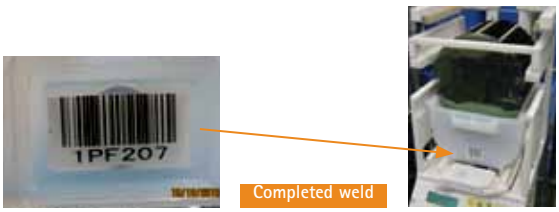
- Entegris committed to their challenge and developed a plan and solution on how to integrate an HF RFID tag in the 200 mm PFA wafer process cassette.

Front carrier view



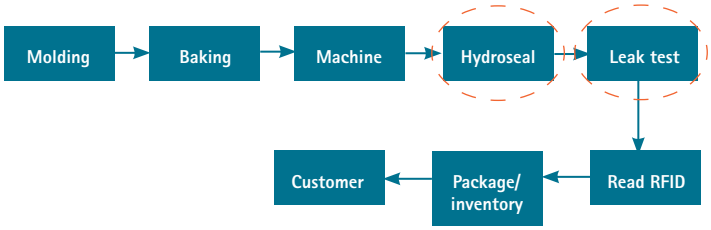
Rear carrier view

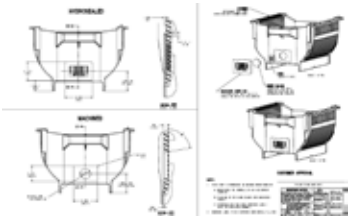
Hydroseal welding integrity check after high temperature and chemicals. No leaks.



Project challenges

- To identify the correct and most suitable RFID tag (type, size) based on HF 13.56 MHz and standard ISO 15693 protocol
- To identify the location on the PFA wafer carrier based on surface area, flatness and distance to HF readers in respect to 25 fully metalized wafers (metal reduces reading distance)
- Optimize sealing temperature & pressure for RFID tag to withstand Entegris hydroseal process
- Leak test, HF RFID tag to be fully encapsulated to withstand Fab process chemicals such as H_2SO_4 (Sulfuric acid) and HF (Hydrofluoric acid) at raised temperatures





Conclusions

The customer has successfully been using Entegris new hydroseal RFID solution in 200 mm PFA wafer process cassettes for more than 14 months.

Customer experienced:

- **increased lot traceability,**
- a reduction in number of operator handling steps resulting in an **improvement in productivity**.

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Product Highlight

NT® Proportional Control Valve
Model 6300

The NT® Proportional Control Valve, Model 6300 is developed for use in ultra high-purity applications. Compatible with highly corrosive processes and designed for use in the wet etch & clean and CMP slurry applications, this valve is an **ideal choice to solve today's flow control needs**.

Featuring PTFE for all wetted parts and inert materials for nonwetted parts, the valve is resistant to harsh chemical environments and external spray-downs.

With the latest motor driver technology, the internal electronics control all aspects of the valve's stepper motor. The valve is actuated using Entegris' advanced algorithm design to maintain the desired set point.

- Nonmetallic components for corrosion resistance
- Double diaphragm construction for containment and contamination protection
- Optimized seat and diaphragm design to minimize dead volume and fluid shear; reliable control from fully closed to fully open

Specifications

Materials of construction:	
Wetted parts:	Body and diaphragms: PTFE
Nonwetted parts:	Polypropylene cover and base plate, Viton®
Response time:	< 2 seconds from 5 to 95% full scale
Pressure range:	-14.5 -60 PSIG (-100 - 414 kPa)
Over pressure limit:	100 PSIG (689.5 kPa)
Process temperature:	10°-65° C (50° - 149° F)
Electrical input:	24 VDC (±10%, regulated)
Setpoint input signal:	4-20 mA, 0-10 VDC, 0-5 VDC; separate homing line also included
Enclosure:	NEMA 5/ IP54

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