



## Liquid Filtration Solutions

*Removing defect-causing contamination to increase yield and reliability*



## Controlling Contaminants

Controlling contamination has a clear goal to improve manufacturing yield and reliability by reducing wafer defect rates. Particles, gels, and metals all cause varying types of surface abnormalities that lead to defective products. Latent defects, those failures discovered in electronic devices in the field, are the most expensive and require a focused approach in terms of particle and

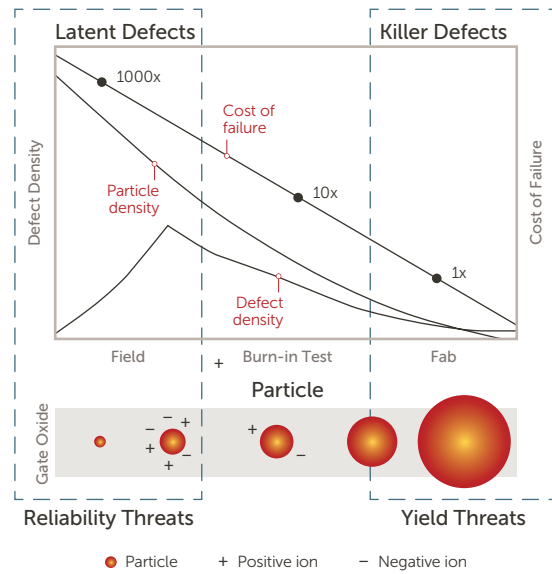
metallic contamination management strategy. Liquid filters and purifiers provide a line of defense to prevent defect-causing contaminants from reaching the wafers and substrates. Entegris provides a wide range of solutions to address your productivity and reliability requirements regardless of the technology node.



*We help customers improve their productivity and performance by providing reliable materials and cost-effective solutions for current and new technology nodes.*

## Improving Semiconductor Reliability

Latent defects are a critical challenge for semiconductor makers focused on automotive, medical devices, military, aerospace, IoT, and other applications requiring increased reliability performance. Contamination in chemical processes has emerged as a source of latent defect formation. With the help of liquid filters and purifiers to remove smaller particles and metal ions in the semiconductor fab, the cost of failures and recalls for electronic devices in the field decrease.



## Liquid Filtration and Purification Core Capabilities

For more than 50 years, Entegris has developed broad capabilities in contamination control, high-purity materials, and material handling to purify, protect, and transport the critical materials that enable applications in many technology industries. Our relentless pursuit of purity has led to solutions

for particle, gel, agglomerate, and metal ion contamination in chemicals, water, and other process materials. This comprehensive portfolio of liquid filtration and purification products helps in your goal for zero defects and enables you to achieve process efficiencies and lower costs.

# Products



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## Photolithography

Photolithography, or “photo” processes, are among the most technologically sophisticated manufacturing operations. Semiconductor engineers and technicians demand solutions that reduce yield ramp times and create sustainable operations to meet their roadmap goals. We rely on our material science and process engineering expertise to develop reliable, cost-effective solutions for both wet and dry photolithography processes.

### *Point-of-Use Filters*

#### **IMPACT® POINT-OF-DISPENSE PHOTOCHEMICAL FILTERS**

Entegris offers best-in-class, ultraclean point-of-use Impact 8G photochemical filters for use in <28 nm lithography nodes, as well as robust, Impact 2 V2 filters ideal in 28 to 250 nm lithography nodes. Impact filters are optimized for various photoresists and solvents including ArF, KrF, BARC, top coat and pre-thinner, that deliver superior flow rate performance and reduced microbubble formation.

- Impact 8G filters are available with Oktalex™ membrane technology for targeted contaminant removal
- Enhanced ultraclean (UC) filter cleaning technology enables rapid startup
- Low hold-up volume minimizes chemical waste
- Impact 2 V2 manifold design enables rapid filter connection to compatible dispense systems or independent manifolds



#### **OPTIMIZER® PHOTOCHEMICAL FILTERS**

Entegris offers various Optimizer point-of-dispense and point-of-tool filtration solutions specially design for organic solvent and aggressive solvent applications, as well as DI water, and aqueous developers. These advanced, ultraclean filters have superior contamination control capabilities at <20 to 250 nm lithography nodes.

- AT, AUC, and ST designs available to meet your chemistry, retention rating, and operating needs
- Enhanced cleaning technology is available to ensure lower particles and reduced organic and metal leachable contaminants
- Long capsules are available that have enhanced flow rate performance and enable shorter filter startup intervals



## Photolithography (continued)

### *Bulk Purifiers and Filters*

#### **PURASOL™ SN/SP SOLVENT PURIFIERS**

We offer ultraclean, Purasol solvent purifiers for removing dissolved and colloidal metal contaminants from a wide variety of ultrapure, polar, and nonpolar solvents including difficult to remove ketones like cyclohexanone. Using uniquely tailored membrane technology, these versatile purifiers reduce defects in critical process streams.

- UPE purification media ensures superior cleanliness
- Broad chemical compatibility with most organic photochemical solvents
- Provides single or sub ppt contaminant removal making them ideal at all technology nodes



#### **MICROGARD™ FILTERS**

Offering clean, solvent-based filtration with high flow rate performance and contaminant retention capabilities in bulk photochemical manufacturing and solvent-based applications. The Microgard filter portfolio provides high-throughput filtration for <10 to 250 nm lithography nodes.

- UC, Plus/UPE, and LE Nylon designs available to meet your bulk, solvent-based photochemical filtration needs
- Advanced cleaning technology further reduces particle shedding, and metal and organic extractables
- UPE membrane provides low surfactant binding and excellent wettability
- Advanced non-sieving nylon membrane technology improves contaminant removal efficiency





## Wet Etch and Clean (WEC)

Wet etch and clean processes touch wafers more than any other tool process in the semiconductor fab. These critically-important processes modify and clean the wafer surfaces to meet the demanding yield and reliability requirements of an efficient fab. These processes utilize the most aggressive chemistries including strong acids/bases and solvents in high concentrations and at elevated temperatures. WEC process materials and repeatability and consistency parameters must be controlled. We provide filtration solutions that succeed under these extreme conditions. Featured products include:

### QUICKCHANGE® NX SERIES FILTERS

Filtration solutions for aqueous, outgassing, and aggressive acid and base chemistries in 28 nm or greater technology nodes. Clean, QuickChange NX Series filters enable high-temperature filtration with high flow rate and retention performance.

- Nondewetting PTFE technology prevents filter failure in outgassing and aqueous chemistries
- Ultraclean options available to minimize tool downtime
- Available prewet with ultrapure DI water for rapid tool startup



### GUARDIAN™ ECD FILTERS

Ultraclean filtration solutions for dilute acid and base chemistries in all technology nodes. Clean, Guardian ECD filters enable low-temperature filtration with reliable flow rate and contaminant retention performance.

- Surface-modified media capable of performing across a wide range of pH applications
- Ultraclean technology provides low metal, chloride, and particle counts to improve startup time
- Hydrophilic membrane eliminates filter prewetting, improves startup time, and reduces tool downtime



## Wet Etch and Clean (WEC) (continued)

### ETCHGARD® HP/HPX FILTERS

High-performance filters for HF and BOE recirculation bath processes in  $\geq 10$  nm technology nodes. The high-efficiency, high-flow membrane delivers reliable contaminant retention, improving bath quality, and enabling high bath turnover.

- Surface-modified membrane is non-interactive with typical plating chemistries
- Hydrophilic media eliminates prewetting and flushing, and allows for rapid installation
- High membrane-area cartridge provides high flow and rapid particle removal in recirculating applications



### PROTEGO® PLUS PURIFIERS

All-in-one purifying filters that meet strict customer requirements for particle control in the most demanding sub-28 nm technology nodes. Protego Plus IPA purifiers are designed to capture trace metal ions in IPA cleaning applications, while Protego Plus DI water purifiers enable superior removal rates of multiple metallic cation contaminants in single-pass or recirculation DI water applications.

- High ion exchange (IEX) capability delivers proven performance to capture trace metal ions and reduce particle shedding to very low levels
- High-metal removal capacity extends purifier/filter lifetime and reduces tool downtime
- Ultraclean product design promotes fast startups, reliability, and high yields at both low and high temperatures



## Chemical Mechanical Planarization

Chemical mechanical planarization (CMP) continues to evolve and gain critical importance in semiconductor environments as the geometry and line spacing of the wafer designs become more complex. To enable these advancements, we have developed a full suite of filtration solutions compatible with a wide range of slurry and abrasive materials. The full filtration portfolio includes bulk/CDS, point-of-tool, and point-of-dispense filtration. This increases the opportunity employ contaminant controls across the slurry delivery path to remove defect-causing materials before contacting the polished wafer.

### PLANARGARD® NMB BULK SLURRY FILTERS

We offer best-in-class Planargard NMB filters for bulk slurry filtration in sub-45 nm technology nodes. Planargard NMB filters have ultra-high particle-loading capacity for bulk CMP processes, and offer superior hard particle removal and gel retention.

- Nano melt-blown technology more efficiently removes agglomerates and gels in bulk slurry processes
- Low-shear-force filtration improves operational efficiency



### SOLARIS® NMB POINT-OF-TOOL SLURRY FILTERS

For point-of-tool slurry filtration in sub-45 nm technology nodes, we offer best-in-class Solaris NMB filters that maintain low Large Particle Counts (LPC) and consistent particle size distribution. They are specially designed to reduce critical LPC in various applications, especially optimized for colloidal silica, ceria, and very fine alumina slurries.

- Low hold-up volume design with minimal dead space that reduces the entrapment of "seed" particles, eliminates potential slurry dry-out, and minimizes waste
- Reduced LPC with no change to particle size distribution
- Nanofibers and multilayered continuous melt-blown (CMB) media provide an improved flow path with high retention





## Chemical Mechanical Planarization (continued)

### PLANARCAP® NMB POINT-OF-DISPENSE SLURRY FILTERS

Planarcap NMB point-of-dispense slurry filters have ultra-high particle loading capacity in sub-45 nm technology nodes. The advanced nanofiber continuous melt-blown (NMB) media technology enables superior hard particle removal and gel retention performance.

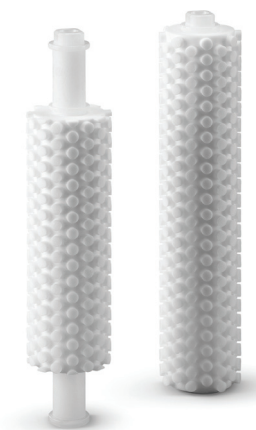
- Nanofiber continuous melt-blown technology more effectively removes agglomerates and gels to reduce micro scratches and extend filter lifetime
- Increase operational efficiency by strategically installing at the final dispense point just before the slurry contacts the wafer



### PLANARCORE® PVA BRUSHES

Planarcap PVA brushes with molded polypropylene (PP) disposable cores are designed to deliver superior performance and wafer-to-wafer uniformity in post CMP wafer cleaning applications. The unique molded-through-the-core technology provides absolute adhesion of the PVA (polyvinyl alcohol) to the PP brush core and will not lose concentricity during use.

- Molded-through-the-core construction allows rapid and consistent installation and eliminates alignment and gapping problems, reducing system downtime and increasing throughput
- High-purity PVA dramatically reduces brush break-in and flush-up times, and allows low extractables and reduces particle counts on wafers
- Close molded technology brush design equilibrates flow through the brush, eliminating the risk of non-repeatable and non-predictable performance



# Bulk Chemical Manufacturing and DI Water

## *Bulk Chemical*

Chemical manufacturers utilize filtration solutions throughout the development and production stages to remove contaminants and replicate the processes used by their customers. Incorporating filters and purifiers in your processes to remove particles, gels, and other contaminants prior to product packaging increases the chemical performance and reduces defect rates.

### TRINZIK™ FILTERS

Our line of Trinzik HCE, HCO, and HCM filters that provide hydrophilic and hydrophobic filtration of ultrapure electronic-grade solvents, and dilute acids and bases in sub-45 nm technology node bulk chemical processing applications. Compared to conventional filter media, these advanced membrane designs provide a significantly more porous surface area that enables good contaminant retention and increased flow rate.

- High-porosity hydrophilic and hydrophobic PTFE membranes enable high flow rate performance and reduce operational costs
- Small pore size membrane designs provide advanced particle removal and increase yields
- Materials of construction have lower extractables that ensure cleaner filtration operations



### TORRENTO® FILTERS

Utilizing the latest membrane and cleanliness technologies, we offer Torrento X series traditional radial filters to meet the most critical demands of aggressive acid, base, and cleaning applications. For solvent and BEOL strip chemistries containing high levels of solvents, we offer Torrento S series filters. Torrento filters improve flow rate performance, filter cleanliness, and contamination control in sub-22 nm device nodes.

- Torrento X filters feature leading-edge FlowPlane™ linear filtration technology to achieve reliable particle protection in sub-22 nm nodes.
- Provides ultimate particle and contamination control in solvent and wet applications
- Specialized organic cleaning options available for ultimate reduction in filter startup time
- Advanced filter formats maintain flow rate performance at high retention ratings



## Bulk Chemical Manufacturing and DI Water (continued)

### *Deionized Water*

Deionized (DI) water is a critical component in semiconductor manufacturing. It is a blending agent in critical dilute chemistries and is also used in wafer drying processes. As water droplets form during the drying process, the resulting water marks must be removed. In each of these applications, clean water is fundamental to improving cost of ownership and maximizing process effectiveness.

#### **PROTEGO PLUS DI WATER PURIFIERS**

High-efficiency, all-in-one purifying filters that deliver ultimate protection from metal ion contamination in critical DI water cleaning applications. The ultraclean, Protego Plus DI water purifier promotes fast startups and high yields at both ambient and elevated temperatures up to 80°C (176°F).

- High ion exchange (IEX) capability enables low metals extractables with fewer particles on wafers
- Advanced cleaning technologies reduce cationic metals, chlorides, NVR, and particle shedding
- Reliable metal ion removal performance minimizes system downtime



#### **TRINZIK UPW ULTRAPURE WATER FILTERS**

Designed for high-performance hydrophilic filtration of ultrapure and DI water in chemical manufacturing applications, Trinzik UPW filters effectively control contaminants in make-up water, polish loop, resin trap, and general process tool water.

- High-porosity hydrophilic PTFE membrane enables high flow rate performance and reduce operational costs
- Polypropylene materials of construction have lower extractables that ensure cleaner filtration operations
- Small pore size membrane design provides advanced particle removal and increases reliability



## Chemical Housings

The purpose and value of filter housings extend beyond the exterior façade. The filter housing is a vessel that provides a variety of performance, reliability, and operator safety benefits. Polymer housings, or those with a PTFE lining, are typically used in higher cleanliness applications and applications that are more sensitive to metals that leach into the process materials.

### CHEMLOCK® HOUSINGS

We offer polypropylene (PP) and PFA Chemlock housings that can be used with various cartridge filters and purifiers in bulk chemical and microelectronic-grade chemical applications. The space-saving housings enable hassle-free cartridge changeouts and reduced exposure to chemicals. The all-PFA option provide broad chemical compatibility at elevated temperatures.

- Compact design enables virtually hands-free cartridge changeouts
- Minimal clearance cartridge/bowl design saves at least 8" of vertical space over traditional housing installations
- Available with extremely robust and clean, industry-leading PrimeLock® connections that provide enhanced reliability and safety within your system



## Why Entegris?

As mega-trends such as artificial intelligence, smart cars, the Internet of things, and augmented reality evolve to meet the growing needs of speed, scale, and reliability, they put pressure on integrated device (IC) manufacturers to increase processor power efficiency and memory size. As device manufacturers strive to produce higher performing chips with more complexity and component integration at acceptable efficiencies and yields, they face significant challenges in terms of process control and economics.

With our broad portfolio of microcontamination control, advanced materials handling, specialty chemicals, and engineered materials, we are uniquely positioned to help customers face these challenges and meet these new worldwide consumer and business data demands at lower costs. Ongoing investments in technology, robust manufacturing, and supply-chain capabilities make us a proven, trusted partner. Our global infrastructure, technology portfolio, and operational excellence are unmatched by the competition. Investments in newer and purer materials enable us to provide the cleanest and most reliable polymer solutions to protect your overall process quality and efficiency.

## Proven Quality and Performance

At Entegris, we have a relentless commitment to operational excellence. Our desire to be a relevant, trusted, technology partner drives us to identify complex problems critical to our customers, quickly develop a working solution, and move from pilot to high volume manufacture (HVM) seamlessly in record time. In our pursuit to be the best performing operational platform in our market, we have aligned our Quality systems to industry requirements and provide capabilities to meet/exceed customer expectations.

Motivated to supply consistent and predictable product performance to customers, reduce quality excursions, and minimize scrap, we have invested in advanced statistical process control (SPC) systems across all our manufacturing sites around the world. Integrated SPC provides immediate recognition of special variation causes enabling faster problem resolution, providing early quality alerts, and allowing easier decision-making to ensure process consistency and minimize product variation.

Customer requirements are demanding so we are always striving for practical, quantifiable, sustainable continuous improvement. By employing lean Six Sigma techniques and tools, we identify and remove the causes of process defects that enable us to improve quality. By minimizing variability in manufacturing and business processes, our DPPM (defective parts per million) performance has also dramatically improved.

Ensuring product performance standards are met, proven techniques such as ISO 9001 certified manufacturing sites, documentation control, and quality testing are utilized. Each manufacturing capability has been developed, tested, and improved to create pure, durable, consistent, and reliable products.

- Injection molding
- Rotational molding
- Blowmolding
- Extrusion
- Tool design/making
- Welding and flaring
- Overmolding
- Prototyping
- Machining

With nearly 2,000 issued U.S. and foreign patents, we have the expertise to develop process knowledge and products that enable innovation and efficiencies. Combining advanced engineering and design expertise with tools such as Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD), and MoldFlow® analysis and modeling enables us to optimize product design and speed technological advancements. In addition to innovative design, we also use R&D and quality lab analysis and testing capabilities to develop dependable solutions.

### QUALITY TESTING

- Vibration and shock
- Safety and industry standardization
- Trace metals
- Electrostatic charge

### PERFORMANCE TESTING

- Particle testing
- Flow rate optimization
- Ion chromatography
- Failure analysis



*We are dedicated to developing the purest products that assist in your goal for zero defects, and gain you the greatest operational efficiency.*

## Sales and Applications Support

Entegris continually invests in expanding analytical and technology center capability globally. Our global direct sales team, sales channel partners, local applications engineers, and world-class customer service give you the support and expertise to solve your most difficult problems. This intimacy allows us to better understand

your needs through direct feedback and roadmap sharing. By aligning our materials science, engineering, and R&D initiatives, we can develop indispensable contamination-control and high-performance solutions to solve your roadmap challenges.

## eCommerce

Entegris has deployed an online purchasing and transaction management system that provides full eCommerce capabilities for our customers. For us, eCommerce is more than just a shopping cart, but rather a robust technology platform designed to deepen customer engagement and deliver value at every touchpoint. Driven by our customers' desire for

lower costs, improved accuracy, and overall increased satisfaction, we have implemented state-of-the-art tools and full integration with our back-end systems to allow automated access to information, accelerated and easier transactions, and a convenient means to collaborate and do business.

## Logistics Expertise

To support your logistics requirements, we manage the infrastructure and service provider partnerships, offering broad capabilities to ensure your supply chain door to door. Providing import processing, insurance, and transportation, we bring expertise in air, ocean, LTL, intermodal, small package, and hazardous

shipments. You will receive in-house, regional logistic support in the U.S., Germany, Israel, South Korea, Japan, Taiwan, Malaysia, Singapore, and China. And our top-ranked freight partners provide import processing services and transportation to all the remaining locations around the globe.



*Our global infrastructure with local R&D, manufacturing, and support focuses on specific customer needs throughout the world.*



## Corporate Social Responsibility

Entegris has a strong commitment to Corporate Social Responsibility and seeks to create value responsibly. We balance the demands of doing business with the need to protect the environment and its resources and to ensure the health and safety of our employees, customers, and the communities in which we work and live.

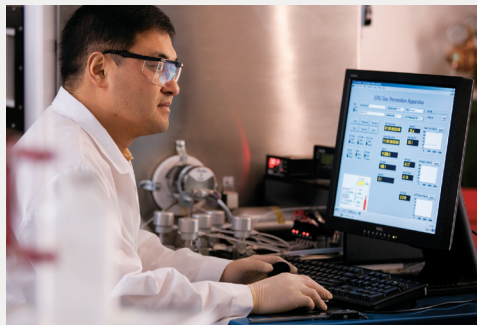
We are committed to applying these principles to product stewardship, environmental protection, employee health and safety, and plant security. In

addition, we are committed to aligning our operations with the Electronic Industry Code of Conduct (EICC). Our new product development process is mindful of Department for Education (DfE) principles to ensure new designs meet customer and governmental material content restrictions, such as PFOA elimination, conflict minerals, and banned substances. We also work on developing strong relationships with our suppliers to ensure their commitment to EICC principles and product material content.

## Experience You Can Count On

Contamination control is critical to your manufacturing processes and has a direct impact on production yields, product reliability, and operational efficiency. We focus on understanding your processes, sources of contamination, and on developing material-enabled solutions to ensure the cleanliness and integrity of those processes. We invest in identifying where impurities may be introduced, and take corrective actions to prevent them, which is a critical first step in contamination reduction efforts.

Trust us to support your vital applications and goal for zero defects by providing the highest purity, highest quality, and most robust products. Our reliable, cost-effective liquid filters and purifiers provide a line of defense to prevent defect-causing contaminants in current and new technology nodes.



*Our ability to innovate new technologies is based on our deep knowledge of materials science and analytics.*

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