Chemical Mechanical Planarization

Process control | Cleanliness | Uptime optimization | Uniformity

Entegris
creating a material advantage
Chemical Mechanical Planarization

CMP or Chemical Mechanical Planarization in semiconductor and hard disk drive manufacturing environments continues to evolve and gain critical importance as the geometry and spacing of the wafer and substrate designs become more complex. To enable these advancements, Entegris offers a wide range of products that provide solutions for:

- In fab delivery of bulk and point-of-use CMP slurries to CMP tools
- Removal of particles and gels from CMP slurries prior to contact with the wafer
- Conditioning the CMP pad
- Removal of residue and waste from the wafer surface post CMP
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Entegris provides innovative materials science-enabled solutions for applications across key semiconductor processes to help chip makers solve manufacturing challenges, enhance yield and gain sustainable competitive advantage.

bulk chemical
As wafer sizes continue to increase and line widths shrink, purity requirements become more stringent and precise chemical blending becomes more critical. Whether it’s transport or storage, mixing or dispense, Entegris has solutions to meet bulk chemical handling needs.

substrate handling
Entegris provides wafer handling products to protect and transport prime wafers, wafers being processed, finished wafers, bare die and packaged devices. Products include wafer carriers, wafer shippers, mask and reticle carriers, bare die trays, horizontal wafer shippers, chip trays and film frame shippers.

chemical mechanical planarization
From filtration, liquid and slurry handling, Entegris products enable the CMP process.

wet etch and clean
Ultrapure liquids and gases are purified, protected and transported with Entegris filters, purifiers, valves, fittings and sensing and control products.

photolithography
Entegris’ broad product line enables lithography processing with gas filters and diffusers, purifiers and purification systems, wafer and reticle handling, liquid filtration, purification and control.

puriﬁy, protect and transport

global presence
With 2,800 employees worldwide, Entegris thrives on the challenge to meet our customers’ expectations through a global network of service, technology, manufacturing and applications support teams, all built upon a tradition of product and process innovation.

lab capabilities

Analytical Services
- Airborne molecular contamination
- Surface contamination
- Applications support
- Root-cause analysis

Product Testing
- Performance testing
- Particle testing
- Electrostatic charge
- Vibration
- Flow rate optimization
- Applied statistics
- Safety and industry standardization
- DOT and UN regulations
- CE marking

Material Science
- New material development
- Material characterization
- Material selection
- Material incoming inspection
- Applications support
enabling innovation

The technology roadmaps to produce the next generation of semiconductor devices and microelectronics are presenting unprecedented technological challenges, as well as ever increasing pressure to improve yields and productivity. As the leading provider of contamination control products and services to the global semiconductor and microelectronics industry, Entegris is using its analytical and materials science expertise to develop comprehensive solutions to address critical contamination issues in the fab.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Node</td>
<td>32</td>
<td>22</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>DRAM ½ Pitch (nm)</td>
<td>45</td>
<td>32</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Critical Particle Size (nm)</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Critical Metal Ions (ppt)</td>
<td>1000</td>
<td>1000</td>
<td>100</td>
<td>TBD</td>
</tr>
<tr>
<td>Molecular Contaminants</td>
<td>Surface</td>
<td>Airborne</td>
<td>Airborne</td>
<td>Airborne</td>
</tr>
</tbody>
</table>

Electronics that are smaller, faster, cheaper and more functional

close to our customers

Direct sales and local support gives us the opportunity to achieve customer intimacy.

Customer intimacy helps us better understand our customers’ needs through direct feedback and roadmap sharing.

By aligning our material science, engineering and R&D initiatives, we can develop indispensable contamination control solutions to solve our customers’ roadmap challenges.

Engage in relevant
table

Entegris Milestones

1966: Founded as Fluoroware, Inc.
2000: Begins trading under the ENTG symbol on NASDAQ
2005: Merges with Mykrolis Corporation, a leading provider of liquid filtration and gas purification products and systems
2006: Expands manufacturing facility in Kulim, Malaysia
2007: Acquires Surmet Corporation’s high-purity semiconductor coatings business
2008: Acquires Poco Graphite, an industry leader in high-performance graphite and silicon carbide
2009: Acquires Pureline Co., a fluid handling component manufacturer, in Kangwon-do, Korea
2011: Opens manufacturing facility in Hsinchu, Taiwan
2012: Opens the Advanced Technology Center, manufacturing for 450 mm and EUV, in Colorado Springs, CO
Acquires Entegris Precision Technology, a HDPE drum blowmolding facility, in Yangmei, Taiwan
Opens new facility to provide specialized silicon and diamond-like coatings in Lyon, France
2013: Acquires Jetalon Solutions, a precision chemical sensor and analyzer maker
Our expertise in material science and contamination control enables our customers to meet the demands of the market by reducing costs, enhancing yields, increasing productivity, and improving process control.

The following pages highlight 18 products and services designed to solve your fab challenges by providing best-in-class purification, materials management and process control solutions.>>>
Entegris’ Planargard® melt-blown graded density slurry filters provide CMP applications the critical performance balance between the removal of defect-causing agglomerate gels and the delivery of the necessary slurry solution to the wafer surface.

- Excellent retention of agglomerates
- Removal of disruptive particles only
- No action on the particle size distribution of working particles

Optimized for bulk filtration of CMP slurries

**FEATURE** | **ADVANTAGE** | **BENEFIT**
--- | --- | ---
Graded-density depth filter design | • Defect-causing agglomerates retention in the four layers of the filter | • Reduced potential premature filter “plugging” • Longer filter lifetime
Disruptive particle removal | • No particle size distribution change of the desired slurry particles after filtration | • Consistent slurry delivery to the process
Compatible with Chemlock® housing | • Bowl and cartridge are removed as a single unit | • Easy and rapid changeout • Space saving

**performance (continued)**

- Particles results of tests conducted by Entegris demonstrate that Planargard cartridges do not affect the particle size distribution of working particles.
- Filters tighter than CMP1 can remove desirable working particles, causing premature plugging and reduced removal rates.

**Tailored to application needs**

<table>
<thead>
<tr>
<th>Product</th>
<th>Planargard NMB Filter</th>
<th>Planargard CL Bulk Filter</th>
<th>Planargard CMP Filter</th>
<th>Planargard CS Bulk Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Ceria and colloidal silica bulk slurry applications</td>
<td>Sub-fab CDS filtration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum operating temperature</td>
<td>80°C (176°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum forward differential pressure</td>
<td>0.48 MPa (4.8 bar, 70 psi) @ 25°C (77°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum reverse pressure</td>
<td>0.15 MPa (1.5 bar, 22 psi) @ 20°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available sizes</td>
<td>10”, 20”, 30”, 40”</td>
<td>5”, 10”, 20”, 30”</td>
<td>10”, 20”, 30”</td>
<td>5”, 10”, 20”, 30”</td>
</tr>
<tr>
<td>Available retention ratings</td>
<td>0.3, 0.5, 0.7, 1.0 μm</td>
<td>0.3, 0.5, 0.7, 1.0 μm</td>
<td>0.2, 0.3, 0.5, 0.7, 1.0 μm</td>
<td></td>
</tr>
</tbody>
</table>

**frequently asked questions**

**How do I choose the appropriate Planargard filter for my application?**
You should consider slurry characteristics, such as abrasive types, particle distribution and solid concentration to determine the appropriate Planargard filter for your application. For any question, please contact your local representatives.

**What is the lifetime of a Planargard filter?**
The lifetime varies by the process condition. If you want to know the lifetime of using Planargard filters in your applications, please contact our local representatives for filter analysis and testing.
Entegris’ Planarcap® family of CMP slurry filters are designed for point-of-dispense (POD) applications. Planar caps filters provide the critical performance balance between the removal of defect-causing agglomerate gels and the delivery of the necessary slurry solution to the wafer surface.

- Pleated design providing best combination of surface area and media gradient
- Longer lifetime with improved flow
- Optimized for copper, STI, ILD and tungsten applications to capture particles in silica, ceria or alumina slurries.

**FEATURE** | **ADVANTAGE** | **BENEFIT**
---|---|---
Pleated depth filter design | • Defect-causing particles retention  
• Multi-stage, graded-density design | • Superior lifetime  
• Superior flow
High-retention disposables | • Reduction of micro-scratches and total defects | 
Focused application development | • Designed specially for: - alumina and silica abrasives containing slurries  
- ceria and colloidal slurries | • Defect-causing particles removal  
• Low pressure drop  
• Higher lifetime

**performance**

- Planar caps KPX is designed to maintain a long lifetime and a high particle removal efficiency even in the most hard-to-filter slurries.

**Tailored to application needs**

<table>
<thead>
<tr>
<th>Product</th>
<th>Planar caps KPX Filter</th>
<th>Planar caps LPX Filter</th>
<th>Planar caps TPX Filter</th>
</tr>
</thead>
</table>
| Application | CMP slurry filtration  
POD and POU filtration | Copper, ILD, STI and tungsten CMP applications | STI and Cu CMP |
| Materials | Medium: Polypropylene  
Core, cage, shell: Polypropylene | Medium: Pleated depth polypropylene | Medium: Pleated depth polypropylene |
| Maximum operating temperature | 40°C (104°F) | | |
| Maximum forward differential pressure | 0.27 MPa (2.7 bar, 40 psi) @ 25°C | | |
| Maximum forward / reverse pressure | 0.27 MPa (2.7 bar, 40 psi) @ 20°C (68°F) | | |
| Available sizes | 2.5", 5" | 2.5", 5" | |
| Available retention ratings | 1.0, 1.5 µm | 1.0, 2.0, 3.0, 5.0 µm | 0.1, 0.2, 0.3 µm |

**frequently asked questions**

**Can Planar caps be used in a bulk chemical system?**

No, Planar caps filter is better used for small volume applications. It is not adequate for bulk chemical systems.

**Is there any special treatment needed for Planar caps filters?**

Normally no special treatment is needed for using Planar caps filters. However, you may need pressure activation for sub 1 µm filters. Please contact our local representatives for instructions.
Entegris’ Solaris® graded density CMP slurry filters provide point-of-use (POU) CMP applications the critical performance balance between the removal of defect-causing agglomerate gels and the delivery of the necessary slurry solution to the wafer surface.

- Designed to meet the needs of next-generation point-of-use (POU) slurries
- Self-venting in vertical installation for optimum flow characteristics
- All-polypropylene construction with melt-blown wrapped depth filtration media
- Retention range from 0.3 µm to 5.0 µm
- Optimized for copper, STI, ILD and tungsten applications.

**Solaris® Filter Family**

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>ADVANTAGE</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimized depth media</td>
<td>Superior agglomerate gel holding capability</td>
<td>Longer filter lifetime</td>
</tr>
<tr>
<td>Self-venting filtration</td>
<td>Eliminates dead space and potential for slurry dry-out in the filtration media, ensuring longer life</td>
<td>More efficient startup, Less slurry handling</td>
</tr>
<tr>
<td>Disposable, Connectology® design</td>
<td>Compact stable design, Quick installation</td>
<td>Minimizes downtime, Safer installation</td>
</tr>
</tbody>
</table>

**Performance**

**Solaris NMB Retention Curve**

Note: Characterize media retention by Entegris proprietary protocol of PSL beads solution

**Tailored to application needs**

<table>
<thead>
<tr>
<th>Product</th>
<th>Solaris NMB Disposable Filters</th>
<th>Solaris CL Depth Filters</th>
<th>Solaris CM Depth Filters</th>
<th>Solaris SCR Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum operating conditions</td>
<td>Maximum forward differential pressure: 50 psi @ 20°C (68°F)</td>
<td>Maximum forward differential pressure: 55 psi @ 20°C (68°F)</td>
<td>Maximum operating temperature: 50°C (122°F)</td>
<td>Maximum forward differential pressure: 50 psi @ 20°C (68°F)</td>
</tr>
<tr>
<td>Available sizes</td>
<td>5&quot;</td>
<td>5&quot;</td>
<td>5&quot;</td>
<td>5&quot;, 10&quot;</td>
</tr>
<tr>
<td>Available retention ratings</td>
<td>0.1, 0.2 µm</td>
<td>0.3, 0.5, 0.7, 1.0, 3.0 µm</td>
<td>0.3, 0.5, 0.7, 1.0, 3.0, 5.0 µm</td>
<td>1.5, 3.0 µm</td>
</tr>
</tbody>
</table>

**frequently asked questions**

Does the Solaris filter family have a connectology option?
Yes. All of the Solaris filters can be specified with a connectology manifold.

Can the Solaris Filter Family be used for POD (Point-of-dispense) process?
Yes, you need to consider the space of dimension to install Solaris filters in your POD process.
AMC Tool-Top Filters

A unique chemistry removes critical contaminants at a low pressure drop for production tools.

- High removal efficiency (>95%)
- Removes critical acids, bases and organics from the fab ambient air to reduce contamination risk
- Long life
- Removes a comprehensive array of AMCs in a single filter cell

Optimised for process tool Airborne Molecular Contamination control.
Entegris AMC tool-top filters provide AMC protection for all semiconductor process tools including: wafer metrology, reticle inspection, ALD, EPI, diffusion, CVD, PVD, wet etch, wafer clean, dry etch and CMP.

<table>
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<tr>
<th>FEATURE</th>
<th>ADVANTAGE</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>High removal efficiency (&gt;95%)</td>
<td>Removes critical acids, bases and organics from the fab ambient air</td>
<td>Reduces contamination risk</td>
</tr>
<tr>
<td>Proprietary chemistry developed with key OEMs</td>
<td>Protects optics and process</td>
<td>Qualified by leading fabs</td>
</tr>
<tr>
<td>High surface area</td>
<td>Low pressure drop</td>
<td>Reduces energy requirements and cost</td>
</tr>
<tr>
<td>Optimized blend of treated, untreated activated carbons and ion-exchange media</td>
<td>Balanced mix to match lifetimes for all contaminant classes</td>
<td>Provides targeted contaminant removal</td>
</tr>
<tr>
<td>Data-driven See It. Control it. methodology</td>
<td>Clearly identifies critical AMC levels in customer’s facility</td>
<td>Provides tailored, application-specific filtration solutions</td>
</tr>
<tr>
<td>Product backed by Entegris OEM certified, ISO 17025 accredited laboratory services</td>
<td>Product performance windows are clearly defined</td>
<td>Provides assurance that all performance claims are verified with supporting data</td>
</tr>
<tr>
<td>Available in a range of sizes to satisfy various installation requirements, including tool-top, fan filter unit, tool interface or in-tool housing in all equipment front-end modules (EFEM) and process modules</td>
<td>Field tested and proven</td>
<td>Easy to implement and install</td>
</tr>
</tbody>
</table>

**performance**

Filter lifetime estimate: actual filter life is determined by measuring the fab's chemical challenge concentration, downstream quality and testing of returned filters.

- **Typical Lifetime**
- **Pressure Loss vs. Velocity**

**frequently asked questions**

**How do I choose the correct filter for my application?**

Our recommendation is based on different parameters such as: AMC targeted, flow rate, maximum pressure drop acceptance, mechanical dimensions and expected lifetime.

**How do we determine filter lifetime?**

Entegris provides on site and post mortem analysis to optimize filter changeouts.
Microenvironment Control Solutions

The Spectra™ FOUP is a 25+1 capacity front opening unified pod (FOUP) that provides high-performance wafer transport, optimum automation integration and low cost of ownership for your facility.

- High-strength assembly
- Wafers protected against shock and vibration
- Meets all applicable SEMI® standards
- Uses STAT-PRO® 3000 carbon-filled PEEK™ material at all wafer contact points
- One piece molded shell
- Optional configuration available for a conductive shell to increase protection
- Microenvironment control

Optimized for below 45 nm processing.

Performance

Microenvironment control: A system approach
- Entegris Barrier Material (EBM) to improve purge duration, quicker purge down time and less absorption/desorption of outgassing from wafers
- Snorkel purge option to rapidly purge down to low moisture and oxygen levels while directing airflow between the wafers
- Clarilite® Wafer for maintaining low moisture or oxygen conditions for extensive time frames

Challenges in wafer microenvironment control

- Process Acid Base Organic O2 H2O Dopant
  - Gate Oxide
  - Ultra Shallow Junction
  - Copper seed to plate interface
  - Exposed Copper Corrosion
  - Reticle Storage
  - HSQ (hemispherical glass) Poly
  - Salicide contact formation
  - Scribe
  - EPI/Pre-EPI
  - Lithography (photoresist sensitivity)

Purging with inert gas will remove moisture and oxygen during or between critical process steps. Etching and deposition steps are prime examples.

- Reduces corrosion and hazing issues
- Improves yield
- Improves queue processing time
- Helps control environmental contamination due to:
  - Outside contamination (atmosphere)
  - Outgassing of the wafers
  - Outgassing of the FOUP (humidity)

Frequently Asked Questions

What kind of identification options are offered?
- Various shell colors for segregation
- Colored inserts on handles
- License plate
- Molded-in bar code
- Print-on-demand labels
- Laser marking

Why 25+1 slots instead of 25?
One slot can be used for a test or monitor wafer.
Planarcore® PVA Brushes

Designed for use with Applied Materials®, Ebara® and Ontrak® CMP equipment, Planarcore® PVA brushes feature molded-through-the-core construction for superior performance and wafer-to-wafer cleaning consistency.

- Easy installation
- Reduce downtime on tool
- Decrease defectivity on wafer
- Consistent cleaning for the period of brush life
- Optimized for the needs of next-generation copper and ILD applications.

FEATURE
Molded-through-the-core design

ADVANTAGE
- Allow rapid and consistent installation on tools
- Eliminate alignment and gapping problems
- Remain dimensionally stable

BENEFIT
- Reduce system downtime
- Increase system throughputs
- Keep concentricity during use

High-purity PVA

- Allow for more efficient cleaning of PVA in manufacture
- Reduce brush break-in and flush-up time
- Low extractable and reduced particle counts on wafers

- Deliver the most consistent performance
- Quicker CMP tool startup

Close molded technology

- Very good core flow equalization

- No risk of non-repeatable and non-predictable performance due to inconsistent flow rates through the length of the brush

Performance

The results of an accelerated tribological stress evaluation (48-hour marathon run) of PVA brushes show the following:

- The post-CMP cleaning comparative evaluation of Planarcore in a Cu/Low-k process was found to be similar or better than the fab POR slip-on-the-core design brushes in a third-party characterization of brushes

- The total variation range of dynamic coefficient of friction (COF) for Planarcore seems to be minimum vs. slip-on-the-core PVA sleeve design of two other suppliers.

Frequently asked questions

What is the cleanliness of our brush?
We have low impurity with metals, ions and particles.

What are the main differences or advantages vs. competitors?
The major advantages we have, compared to our competitors include ease of use, brush break-in process, wafer-to-wafer consistency and longer lifetime.
Planargem® Pad Conditioners

Designed to maintain constant surface morphology and consistent material removal rate, preventing “glazing”.

- Infinite pattern design flexibility
- Tuned diamond film properties
- Reduced scratch defects
- Consistent pad cut rate performance
- Longer lifetime

Optimized for harsh environments and chemistries such as in-situ Tungsten, as well as configuration for sub-20 nm technologies requiring gentle conditioning when polishing extremely sensitive surface features.

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>ADVANTAGE</th>
<th>BENEFIT</th>
</tr>
</thead>
</table>
| Polycrystalline CVD Diamond Film | • Enable long life  
• Chemically clean and stable in process chemistry  
• Stronger than natural diamond grit | • Reduce work per facet  
• No internal defects |
| Textured Silicon Carbide Substrate | • Flexible topography design  
• No diamonds to fall out or break off into polishing process  
• Significantly improved disc to disc repeatability | • Tailored to fit customer process  
• Provide reduced CMP process variability |
| Segment Design        | • Assembly flatness  
• Keep ‘flatness’ | • Cost efficient  
• High design flexibility |

**frequently asked questions**

What is the pad cut rate drop performance?

- CVD Film and engineered substrate contribute to stable performance and eliminate conditioner break-in
- Provides savings on both pad and conditioner life
- Tunability of features and coating enable throughput maximization

What are the main differences or advantages vs. competitors?

Our key product benefits include: performance flexibility, lower defectivity, consistency, cleanliness and extended lifetime.
Entegris has the broadest range of configurations and sizes available for Flaretek, FlareLock®II and PureBond® PFA fittings.

- Most complete line of flare and pipe fitting connection applications
- Flare fittings provide leak-free performance in demanding applications
- PureBond weldable pipe fittings provide a rigid, permanent, leak-free piping system
- Broad range of sizes and configurations: flare $\frac{1}{4}$"–1 1/4", PureBond $\frac{1}{4}$"–2" elbows, unions, reducers, caps, tees, crosses and adapters
- Optimized for bulk distribution, valve manifold boxes mainline, wet etch and clean applications: HF, H$_2$O$_2$, H$_2$SO$_4$, H$_3$PO$_4$, HNO$_3$, MAE and chemical mechanical planarization.

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>ADVANTAGE</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFA wetted surfaces</td>
<td>• Provides high purity and chemical resistance</td>
<td>• Lower cost of ownership through increased productivity and throughput</td>
</tr>
<tr>
<td>Largest installed customer base of PFA fittings</td>
<td>• Global manufacturing and support</td>
<td>• Assured reliability and performance</td>
</tr>
<tr>
<td>Available in a broad range of sizes and configurations</td>
<td>• Single source supplier for all high-purity, corrosive chemical connection needs</td>
<td>• Suitable for a wide variety of high-purity applications</td>
</tr>
</tbody>
</table>

**performance**

| Maximum Pressure Capabilities @ Room Temperature Values in psig (kPa) |
|---|---|---|---|---|
| Size | PVDF Nut | PFA Nut | CPFA Nut | FlareLock II PFA Nut |
| $\frac{1}{4}$" | 225 (1551) | 225 (1551) | 225 (1551) | 225 (1551) |
| $\frac{3}{8}$" | 225 (1551) | 225 (1551) | 225 (1551) | 225 (1551) |
| 1/2" | 190 (1310) | 190 (1310) | 190 (1310) | 190 (1310) |
| 3/4" | 110 (758) | 110 (758) | 110 (758) | 140 (965) |
| 1" | 75 (514) | 75 (514) | 75 (514) | 90 (620) |
| 1 1/2" | 80 (552) | — | — | N/A |

**frequently asked questions**

**What is Flaretek?**
The flaring process provides a permanent expansion (flare) of the tubing end, allowing insertion of the Flaretek fitting body.

**What are the tools required to make a proper Flaretek connection?**
A heating source (air gun), mandrel and tube cutter.

**What are the requirements to make a PureBond connection?**
A 1" or 2" Entegris PureBond tool kit.

**What does a X at the end of a part number mean (e.g. E8-8FN-1X)?**
X means fitting body is made of PFA HP Plus and it is recommended for chemicals containing fluorinated surfactants.

**When is FlareLock II recommended?**
For elevated temperatures >100°C or higher pressure (see chart) and before/after pumps (pulsation/vibration).
The simplest, cleanest and most robust PFA fitting on the market.
- PrimeLock® fittings ensure leak-free performance in the most demanding chemical applications
- Easy to assemble, heat is not required
- The audible and visible indicator allows users to verify the proper makeup of the connection
- Broad range of sizes and configurations: ¼” to 1¼” elbows, unions, reducers, caps, tees, minimum tube unions and adapters
- Expanded on a wide range of Entegris products: Chemlock® filter housings, NT pressure transducers, CR4 ¼” and CR8 ½” series valves.
- Ideal for high purity, corrosive chemical handling, low surface tension chemistries and high-temperature applications.

**FEATURE** | **ADVANTAGE** | **BENEFIT**
--- | --- | ---
Ease of assembly | • Audible and visual indication of proper fitting makeup | • Consistent and repeatable fitting makeup
PFA wetted surfaces | • Broad chemical compatibility | • Simplifies product selection
Robust thread design | • Three backup seals | • Consistent leak-free connection
 | • No cross threading |  
 | • Quick makeup |  
 | • Increased sealing forces |  
Unique seal design | • Nonwetted insert eliminates multiple entrapment, leak points and flow interruptions | • Improved process
Capable of 200°C (392°F) temperature rating | • Simplifies product selection | • Lower design cost
No heat required to flare tubing | • Reduces operator variability | • Saves time and money

**performance**

The unique seal design removes the insert from the flow stream
- Reduces entrapment
- Reduces leak points
- Eliminates flow interruptions

PrimeLock ¼”- 1” fittings are compatible with high-temperature chemical processes:
- At temperatures up to 200°C at 40 psi
- At room temperatures it is rated to 120 psi

**frequently asked questions**

When should I use PrimeLock fittings?
PrimeLock fittings can be used in high-purity, corrosive chemical handling, semiconductor applications, solar, LED, flat panel display and with low surface tension chemistries. Also, used in high-temperature applications up to 200°C.

How can I find the appropriate fitting?
You can generate fitting part numbers based on your specifications and search the extensive online catalog on:
- The web at www.entegrisfluidhandling.com
- The mobile selection tool at: m.entegrisfluidhandling.com
Flaretek® 90° Sweep Elbows

Flaretek® 90° elbow with optimized radius eliminates sharp corners to dramatically reduce pressure drop and increase flow. Manufactured from 100% virgin HP PFA material.

- No dead spots
- Increases flow rate in same footprint as standard elbows
- Decreases fluid turbulence for CMP chemical health
- Optimized for high volume bulk chemical distribution and CMP slurry applications.

**FEATURE** | **ADVANTAGE** | **BENEFIT**
--- | --- | ---
Optimized 90° radius | Reduces total system pressure drop | Increases overall equipment lifetime
| Increases flow | Improves yield
| Reduces fluid shear | Improves yield by reducing large particles on wafers
| Reduces dead volume | Maintains chemical integrity
| Decreases turbulence

**Performance**
- 60% lower pressure drop through the fitting compared to the standard 90° elbow
- Smallest footprint sweep available, making it practical for OEM tools
- Reduced footprint design saves assembly time

Achieve better results than standard 90° elbows
- Standard 90° elbow burst pressure: 644 psig (average)
- Sweep 90° elbow burst pressure: 825 psig (average)

**Frequently asked questions**

**What fitting sizes and accessories are available?**
- Fitting sizes: ½”, ¾” and 1”
- Spacesaver or PureBond® connections available
- FlareLock II, PVDF, PFA, CFPA nut available

**What are the pressure and temperature ratings?**
Pressure and temperature ratings are the same as a standard ¾” 90° elbow fitting. Visit [www.entegrisfluidhandling.com](http://www.entegrisfluidhandling.com) for additional information.

**How can I find the appropriate fitting?**
You can generate fitting part numbers based on your specifications and search the extensive online catalog on:
- The web at [www.entegrisfluidhandling.com](http://www.entegrisfluidhandling.com)
- The mobile selection tool at: [m.entegrisfluidhandling.com](http://m.entegrisfluidhandling.com)
Broad range of tubing and pipe made from 100% virgin high-purity PFA material for highly corrosive, ultrapure applications.

- Tube flaring process provides leak-free connections and offers design flexibility
- PureBond weld process is ideal when permanent connections are required
- Non-intrusive, non-contaminating and permanent serialized laser-marking allows immediate material identification
- Standard wall tubing is available in \(\frac{1}{4}\), \(\frac{3}{8}\), \(\frac{1}{2}\), \(\frac{3}{4}\), 1", 1\(\frac{1}{4}\), 1\(\frac{1}{2}\) sizes
- Pipe is available in \(\frac{1}{4}\), \(\frac{1}{2}\), \(\frac{3}{4}\), 1", 2" sizes
- Pipe and tubing are available in different PFA grades

Optimized for bulk distribution, valve manifold boxes mainline, wet etch and clean applications: HF, H\(_2\)O\(_2\), H\(_2\)SO\(_4\), H\(_3\)PO\(_4\), HNO\(_3\), MAE and chemical mechanical planarization.

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>ADVANTAGE</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFA material of construction</td>
<td>- Broad chemical compatibility</td>
<td>- Lower cost of ownership through increased productivity and throughput</td>
</tr>
<tr>
<td>Long-term performance testing at various media temperatures</td>
<td>- Products can be used with confidence at maximum continuous rating</td>
<td>- Added safety</td>
</tr>
<tr>
<td>Laser marked tubing</td>
<td>- Sure method of traceability</td>
<td>- Accurate and easy identification in critical situations</td>
</tr>
<tr>
<td>Available in different PFA grades: 4200, 4300 and 4400 (HP plus)</td>
<td>- Customizable in different material quality requirements</td>
<td>- Increased product performance and longer product life</td>
</tr>
</tbody>
</table>

**frequently asked questions**

Can I use the standard 4200 material with surfactant?
4200 should not be used with fluorinated surfactants.

Are all tubings available as coiled tubing?
Yes, the standard straight wall tubing can be coiled customized.

Is a convoluted tubing available?
Yes, available in \(\frac{1}{4}\), \(\frac{1}{2}\) and 1" sizes.

How can I identify my installed tubing?
Laser marking identifies the size, and traceability to a material lot number and production inspection record (except 0.030" wall).
CR4, CR8 and CH8 Manual and Pneumatic Valves

CR4, CR8 and CH8 valves are next generation valves specifically designed for corrosive environments.

- Modular design – manifoldable
- Small footprint
- High-temperature capability
- High-purity corrosive chemical handling

CR4 is ideal for low flow wet etch and clean applications and high temperature corrosive chemical handling.

CR8/CH8 is ideal for mid flow wet etch and clean, low volume bulk chemical delivery and high-temperature applications.

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>ADVANTAGE</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular design</td>
<td>• Ease of assembly</td>
<td>• Improves serviceability</td>
</tr>
<tr>
<td></td>
<td>• Easily configured into custom manifolds</td>
<td>• Allows tool manufacturer to optimize space</td>
</tr>
<tr>
<td></td>
<td>• Compact footprint</td>
<td></td>
</tr>
<tr>
<td>High-temperature capability</td>
<td>• Solves variety of critical issues including photoresist stripping</td>
<td>• Improves yield</td>
</tr>
<tr>
<td>Vented actuator design</td>
<td>• Able to withstand corrosive environments</td>
<td>• Improves reliability</td>
</tr>
<tr>
<td></td>
<td>• Extends product lifetime</td>
<td></td>
</tr>
<tr>
<td>Variety of end connections</td>
<td>• Versatility and ease in system design</td>
<td>• Improves cost of ownership</td>
</tr>
<tr>
<td>Available in 3-way configurations</td>
<td>• Three-ported directional valve design</td>
<td>• Enables simplification of system design</td>
</tr>
</tbody>
</table>

**performance**

- Sealed actuator with separate actuator vent port
- Ability to vent the actuator through a separate vent line to a controlled environment

**performance (continued)**

<table>
<thead>
<tr>
<th></th>
<th>CR4</th>
<th>CR8/CH8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orifice</td>
<td>⅛”</td>
<td>⅛”</td>
</tr>
<tr>
<td>Media temperature range</td>
<td>21°C – 160°C</td>
<td>CR8: 21°C – 130°C</td>
</tr>
<tr>
<td></td>
<td>CR8: 21°C – 180°C</td>
<td></td>
</tr>
<tr>
<td>Inlet/outlet pressure rating at RT</td>
<td>CR4: 80 psig / 40 psig</td>
<td>80 psig</td>
</tr>
<tr>
<td>Cv</td>
<td>0.29 – 0.84</td>
<td>2.4 – 3.4</td>
</tr>
<tr>
<td>Reliability</td>
<td>Tested over 2.1 million cycles</td>
<td>Tested over 4 million cycles</td>
</tr>
</tbody>
</table>

**frequently asked questions**

What configurations are available?

- Pneumatic, toggle or multi-turn actuators
- ¼” to ½” port sizes
- Flaretek, PureBond, Pillar S300 or PrimeLock connections
- Options for position indicators, restricted open and close, LOTO etc.

Is there a 3-way CR valve available?

Yes, it is available ¼” to ½” pneumatically actuated.

Are all CR valves actuators manifoldable?

Yes, all 2-way and 3-way valve types with all actuator configurations can be manifolded.

When should I choose CH8 vs. CR8?

When temperature exceeds 130°C (266°F), CH8 should be selected. CH8 can support up to 180°C (365°F).

Why should I use CR4 instead of SG4?

- CR4 has no exposed metal hardware and will be more resistant to corrosive environments.
- Higher temperature capabilities compared to SG4 series
- Improve ease of field repairability
- CR4 is a direct replacement for SG4

**CR4, CR8 and CH8 Manual and Pneumatic Valves**
**NT® Electronic Flowmeters, Model 4400**

NT® electronic flowmeters are ideal for capturing critical diagnostic information for monitoring or controlling process applications.

- Provides simultaneous measurement of outlet pressure and flow rate
- No moving parts offers reduced particle generation potential
- Optimized for use in ultra high purity applications in the semiconductor industry.

**FEATURE** | **ADVANTAGE** | **BENEFIT**
---|---|---
No moving parts | • No particle generation | • Yield improvement
 | • Provides repeatable and reliable measurements | • Throughput improvement
Flow-through design | • Minimizes dead volume | • Contamination potential reduction
Integral pressure transducer | • Additional process information supply | • Process control enhancement

**performance**

| Material-wetted parts | Body: PTFE
Sensor interface: PFA or CTFE
Primary seal: Kalrez® |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials-nonwetted parts</td>
<td>Polypropylene, polyethylene, PVDf and PVC, or FEP-jacketed cable</td>
</tr>
<tr>
<td>Process temperature</td>
<td>10°C to 65°C (50°F to 149°F) Consult factory for higher temperatures</td>
</tr>
<tr>
<td>Electrical input</td>
<td>24 VDC (12-28 VDC input voltage)</td>
</tr>
<tr>
<td>Electrical output</td>
<td>Two 4-20 mA electrically isolated outputs, one for flow and one for outlet pressure</td>
</tr>
</tbody>
</table>
| Process drop | 3 psid at nominal flow, 10:1 turndown
12 psid at nominal flow, 20:1 turndown |
| Operating pressure | 0 to 60 psig (0 to 414 kPa) |
| Over-pressure limit | T100 psig (690 kPa) |

**frequently asked questions**

**What applications can be covered by the NT electronic flowmeters?**

NT electronic flowmeters are best used for monitoring or controlling process applications, such as:

- Chemical, DI water and slurry dispense
- Precision blending and metering
- Totalized flow for custody transfer
- System diagnostics

**What types of sensor interfaces are available?**

CTFE or PFA.
NT® Integrated Flow Controllers, Models 6510 and 6520

NT® integrated flow controllers, models 6510 and 6520 are designed for critical dispense applications, chemical blending and on-demand chemical mixing applications.

- PTFE wetted surface for high-purity applications
- No moving parts offers reduced contamination potential
- Nonmetallic sensing technology based on differential pressure provides reliable measurement
- Compact design

- **NT model 6510** is ideal for aggressive chemical applications where accurate dispense or dosing is needed.
- **NT model 6520** is ideal for high-flow applications such as bulk delivery or tool liquid dispense.

### Performance
Enhancements to valve motor and diaphragm provide improved flow control, added safety and contamination protection.

<table>
<thead>
<tr>
<th>Feature</th>
<th>6510</th>
<th>6520</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor interface</td>
<td>CTFE, PFA</td>
<td>CTFE, PFA</td>
</tr>
<tr>
<td>Flow range</td>
<td>0–15 mL/min to 0-1250 mL/min</td>
<td>0-2.5 L/min to 0-40 L/min</td>
</tr>
<tr>
<td>Flow measurement accuracy</td>
<td>±1.1% full scale &gt;20-100% of full scale flow range</td>
<td>±2.5% full scale 10-20% of full scale flow range</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.5% full scale &gt;20-100% of full scale flow range</td>
<td>±1.1% full scale 10-20% of full scale flow range</td>
</tr>
<tr>
<td>Pressure measurement</td>
<td>0-414 Kpa (0-60 psig)</td>
<td></td>
</tr>
<tr>
<td>Pressure accuracy</td>
<td>±1% of full scale</td>
<td></td>
</tr>
<tr>
<td>Process temperature</td>
<td>10°C – 65°C (50°F -149°F)</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>852 cm³ (smallest IFC on the market)</td>
<td>1744 cm³</td>
</tr>
</tbody>
</table>

### Frequently Asked Questions

**What are the NT integrated flow controller requirements?**
- Line pressure must be at least 10 psig
- Sizing for flow control: target flow (nominal flow) should be within 35 - 90% of a flow controller’s flow range
- Maximum working pressure: 60 psig

**Do bubbles affect pressure/flow measurement?**
No, NT Integrated flow controllers combine a differential pressure-based flowmeter and a leading edge control valve to create a closed loop flow controller.

**What types of sensor interfaces are available?**
CTFE, PFA or CTFE (hydrofluoric acid compatible).

**How do I choose the right interface for my application?**
- CTFE should be used for most aqueous chemical solutions and select solvents
- PFA should be used for solvents, select chemicals and process temperatures above 40°C
- CTFE (Hydrofluoric acid compatible) should be used for HF applications

Please refer to chemical compatibility chart for sensing and control products:
The NT® control module is an integrated display and fully programmable process controller that allows the user to fine-tune control parameters, display settings and alarm set points:
- PID control
- Fully programmable
- Compact design
- Output alarms and local display
- Deviation indication
- Keypad or external set point input
- Programmable alarms and alarm delays
- Optimized to meet flow control needs for chemical and slurry dispense.

### Performance

<table>
<thead>
<tr>
<th>Feature</th>
<th>Advantage</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully programmable</td>
<td>• PID control parameters selection</td>
<td>• Process optimization</td>
</tr>
<tr>
<td></td>
<td>• Settings and alarm set-points display</td>
<td></td>
</tr>
<tr>
<td>Peristaltic pump controller functionality when used with a NT Electronic Flowmeter</td>
<td>• Closed-loop flow control system</td>
<td>• No peristaltic pump calibrations</td>
</tr>
<tr>
<td></td>
<td>• Fluid flow maintenance at the desired set point</td>
<td>• Chemical and DI water usage reduction</td>
</tr>
<tr>
<td>Alarming display functionality when used with an NT Integrated Flow Controller</td>
<td>• Alarm on the difference between actual flow and set point</td>
<td>• Constant flow rates maintenance</td>
</tr>
</tbody>
</table>

**Accuracy**: ±0.2% full scale, plus 1 digit

**Temperature (operating)**: 0°C to 50°C (32°F to 122°F)

### Frequently Asked Questions

#### What is the function of the NT control module as an alarming display?

NT control modules may be used as an alarming display for NT integrated flow controllers or similar set point driven devices.

#### What are the major advantages of an NT control module?

NT control module successfully improves process, reduces costs and increases uptime.
NT® Pressure Transducers

NT® pressure transducers provide accurate and reliable inert pressure measurements, and measure gas or liquid pressure, allowing you to monitor process conditions for increased safety and system performance.

- No moving parts or fill fluids help reduce contamination potential
- Nonmetallic sensing technology provides reliable measurement
- Compact design
- Dymension manifold mountable

Optimized for aggressive chemical applications.

**performance**

- Provides reliable pressure measurement where manual gauges only provide approximate pressure results
- Pressure transducers can help determine filter lifetime where critical contamination control is needed

**frequently asked questions**

Where can I use NT pressure transducers?

- System diagnostics
- System pressure monitoring for tool queuing
- Pressure at chemical distribution modules, valve manifold boxes and point-of-use
- Differential pressure in filtration systems
- Integrated into custom valve manifolds

Can NT pressure transducers, model 4100 be used in high-temperature applications?

Yes, contact Entegris for more information.

How long can model 4150 and 4250 survive 49% Hydrofluoric acid (HF) at 23°C?

Estimated 10 years.

How do I choose the right interface material for my application on pressure transducers, model 4100 and 4210?

- CTFE should be used for most aqueous chemical solutions and select solvents
- PFA should be used for solvents, select chemicals and process temperatures above 40°C.
- For hydrofluoric acid applications, contact Entegris for more information.

Please refer to chemical compatibility chart for sensing and control products:


---

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>ADVANTAGE</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>All wetted parts are constructed of PTFE, sapphire and other high-purity polymers for corrosion resistance</td>
<td>Compatible with typical semiconductor process chemistries</td>
<td>Improves yields by increasing particle performance</td>
</tr>
<tr>
<td>Provides compatibility and easy integration with electronic displays and monitoring systems</td>
<td>Enables tool interaction with pressure transducer and offers increased accuracy in pressure measurements</td>
<td>Increases overall equipment efficiency</td>
</tr>
<tr>
<td>Single port and flow through styles offered with industry standard Flaretek and Super 300 Type Pillar® fittings</td>
<td>Compact design enables easy installation</td>
<td>Improves system design flexibility</td>
</tr>
<tr>
<td>No moving parts or fill fluids</td>
<td>Reduces contamination potential</td>
<td>Increases tool uptime</td>
</tr>
</tbody>
</table>
CR-288® Concentration Monitors

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.

- Integrated data collection, analysis and field calibration
- Improvement on productivity
- Compliant to SEMI Standard F57-0301 for cleanliness, testing and calibration

- Optimized for inline liquid chemical applications.

### Performance

The following performance data is based on operation within the calibrated range, ±10% of the refractive index range.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractive index accuracy (Refractive Index Units, RIU):</td>
<td>±5 × 10⁻⁵</td>
</tr>
<tr>
<td>Refractive index repeatability:</td>
<td>2.5 × 10⁻⁵</td>
</tr>
<tr>
<td>Refractive index resolution:</td>
<td>1.0 × 10⁻⁵</td>
</tr>
<tr>
<td>Concentration accuracy:</td>
<td>±0.05 wt%*</td>
</tr>
<tr>
<td>Concentration repeatability:</td>
<td>±0.025 wt%</td>
</tr>
<tr>
<td>Concentration resolution:</td>
<td>Chemical dependent 0.01 wt% or better</td>
</tr>
<tr>
<td>Temperature accuracy:</td>
<td>±0.2°C (0.4°F)</td>
</tr>
<tr>
<td>Temperature repeatability:</td>
<td>±0.1°C (0.2°F)</td>
</tr>
<tr>
<td>Temperature resolution:</td>
<td>±30.05°C (±0.06°F)</td>
</tr>
<tr>
<td>Response time:</td>
<td>1.2 sec standard, no rolling averaging enabled, rolling averaging is user-configurable</td>
</tr>
</tbody>
</table>

* Based on measuring semiconductor-grade chemicals, such as hydrogen peroxide, in slurries at typical environmental parameters of 25-35 psi with a maximum variation of ±0.25 psi, and temperature of 18°C – 26°C (64.4°F – 78.8°F) with maximum variation of ±0.1°C (±0.2°F).

### Frequently Asked Questions

**For which applications can I use the CR-288 concentration monitor?**

Process monitoring for inline liquid chemical applications.

**What is the interface of the connection?**

Customers can select Flaretek, Super 300 Type Pillar and PrimeLock end connections; other end connections available upon request.

**Can the sensor monitor slurries?**

The sensor uses refractive index technology to monitor chemical concentration and is unaffected by light dispersion through the slurry. It is able to monitor in the presence of particulates and bubbles.
The cryogenic cleaning process consists in projecting CO₂ pellets. As the CO₂ sublimes, it mechanically removes contaminants from the surface.

Cryogenic cleaning acts efficiently for the following applications:
- Stripping
- Remaining burrs
- Cleaning technology
- Decontaminating the organic elements
- Removing grease on all materials

Optimized for CMP part cleaning.

**performance**

Cryogenic decontamination experiment on a CMP equipment blade
- Goal: Remove slurry from a part for immediate use on a machine
- Result: The blade is completely cleaned of slurry and all organic residues. An additional step of precision cleaning can be done in order to remove all particles.
- Benefit: The cleaned part is in perfect shape (no trace, no abrasion, no slurry) and ready for use.

**frequently asked questions**

What materials can be treated by cryogenic cleaning?
Cryogenic cleaning is a dry and non-abrasive process. All materials can be cleaned without damage. For example, plexiglas and polished aluminum can be treated without the surface becoming dull or scratched.
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East Dist., Hsinchu City 30072
Taiwan R.O.C.
Tel. +886 3 571 0178
Fax +886 3 572 9520

Entegris regional customer service centers

<table>
<thead>
<tr>
<th>REGION</th>
<th>TELEPHONE</th>
<th>FAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>800 394 4083</td>
<td>800 763 5820</td>
</tr>
<tr>
<td>Germany</td>
<td>+49 (0) 351 795 97 0</td>
<td>+49 (0) 351 795 97 499</td>
</tr>
<tr>
<td>France</td>
<td>+33 (0) 4 76 35 73 50</td>
<td>+33 (0) 4 76 35 73 80</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>+33 476 357 354</td>
<td>+33 476 357 380</td>
</tr>
<tr>
<td>Italy</td>
<td>+49 (0) 351 795 97 0</td>
<td>+49 (0) 351 795 97 499</td>
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<tr>
<td>Israel</td>
<td>+33 476 357 352</td>
<td>+33 476 357 380</td>
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<td>Japan</td>
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<tr>
<td>Malaysia</td>
<td>+81 3 5442 9718</td>
<td>+81 3 5442 9738</td>
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<td>Korea</td>
<td>+60 4 427 4200</td>
<td>+60 4 641 3294</td>
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<td>Taiwan</td>
<td>+886 3 571 0178</td>
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<td>86 21 5080 5598</td>
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