



Synergies to Improve CMP Yield

*Holistic solutions to
reduce contamination
and on-wafer defects*

Introduction

Shrinking feature size, advances in interconnect metals, and the need for ever tighter defectivity control all point to the growing importance of chemical mechanical planarization (CMP) to optimize fab yields. More layers of each chip require CMP to achieve planarity specifications, and contamination must be kept to a minimum. Planarity and purity are key indicators of each layer's ability to perform as expected. Topographical anomalies and residues may affect the wafer yield, device performance, and long-term reliability of the electronic system.

It is critical that all chemicals and consumables related to the CMP process are compatible with one another. This synergistic approach to CMP must encompass all the materials, components, and systems that interact in the entire process, including post-CMP cleaning.



The slurry is the most critical and expensive part of the process and determines the selection of all other chemicals and equipment.

CMP Process Solutions >

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CMP Slurries

The slurry is the most important part of the CMP process. It serves a simple purpose — removing a thin layer of metal or oxide using a combination of abrasive particles and chemical additives. Slurries are becoming more complex because of the need to polish various metals. Formulations designed for copper will not achieve the same results on molybdenum, tungsten, cobalt, or ruthenium.

The mix of additives such as oxidizing chemicals, corrosion inhibitors, stabilizers, and surfactants must be optimized to control the metal removal rate and ensure consistent results for the specific application. The concentration of hydrogen peroxide (H_2O_2), which oxidizes the metal, degrades over time, so slurry storage is another important consideration.

We are a market leader in the design and production of CMP slurries and our broad slurry portfolio is evolving to provide solutions to meet the complex challenges seen in logic, memory, foundry, wafer substrate, and rigid disk substrate markets. With Entegris you have access to a global application engineering and R&D team that will deliver CMP solutions that solve your technical challenges while optimizing overall cost of ownership.



MOLY CMP POLISHING SLURRIES

Novus™ Slurry Line

High selective bulk slurries and tunable selective buff slurries to meet moly recess-free and high moly rate.

COBALT CMP POLISHING SLURRIES

Novus™ Slurry Line

High selective bulk slurries and tunable selective buff slurries to meet cobalt recess-free and residue-free.

TUNGSTEN CMP POLISHING SLURRIES

Our high-performance tungsten slurries are for the manufacturing of atomically smooth and defect-free wafers.

Semi-Sperse™ Slurry

Semi-Sperse slurry is a line of high-purity fumed silica and unique rate-accelerating agents for selective tungsten removal.

WIN™ Slurry

WIN slurry is a family of tungsten CMP slurries developed to meet the requirements of advanced node applications and offers excellent removal rate, defectivity, and topography for a wide variety of applications.

- Offers a wide variety of solutions, including advanced selective tungsten slurries, non-selective tungsten slurries, and tungsten buff slurries

DIELECTRIC/ADVANCED DIELECTRIC CMP POLISHING SLURRIES

We offer high-purity fumed silica slurries for CMP of interlayer dielectric (ILD) materials and a portfolio of innovative new products for polishing dielectric layers in advanced integrations with new discoveries such as patented selectivity agents, engineered abrasive particles, and tunable removal rates and selectivity.

iDIEL™ Slurry Line

Our iDIEL slurry line offers dielectric slurries including bulk oxide slurries, self-stop slurries, and selective dielectric slurries for a wide variety of polishing applications.

ALUMINUM CMP POLISHING SLURRIES

Our Novus™ product family contains uniquely engineered abrasive particles and chemistry to remove aluminum and the complex stack of work-function metals within the transistor gates of advanced semiconductor HKMG (High-K Metal Gate) devices.

- Designed to stop polishing on oxide material, minimizing aluminum recess
- Formulated to optimize removal rate, limit recess, and meet the most demanding defect requirements

COPPER CMP POLISHING SLURRIES

Our high-performance EPOCH™ copper slurries are for manufacturing atomically smooth and defect-free wafers.

- Copper CMP polishing slurries assume a critical role, influencing both performance and total system cost
- Provide maximum flexibility to meet specific customer integration requirements

SILICON WAFER POLISHING SLURRIES

Prime polished silicon wafers are the key substrate in a wide range of advanced integrated circuit (IC) applications.

- Our SiLECT™ slurry is developed for prime polished wafers, a highly refined, ultrapure crystalline silicon with ultra-flat and ultraclean surfaces that are customized to meet customer specifications

SILICON CARBIDE WAFER POLISHING SLURRIES

Our high-performance [Silicon Carbide \(SiC\) slurries](#) are for scalable manufacturing of low defectivity power and semi-insulating SiC substrates.

- Designed to meet specifications at various stages of the substrate manufacturing process from lapping to CMP for Si-face, C-face, and poly SiC wafers
- Optimized solutions for batch and single-wafer CMP systems to provide a lower cost of ownership
- Slurries are high-volume manufacturing (HVM) ready and compatible with bulk delivery systems
- Advanced formulations that provide ultra-high polishing rate, up to 10× faster than existing processes, while maintaining uniformity and no sub-surface damage, and low defectivity/scratches
- Custom solutions are available upon request
- Also includes Micropol Gen 3, Micropol Gen 7, SC1T, and SiCceed™ slurry lines



POLYCRYSTALLINE SILICON CARBIDE CMP SLURRIES

Our high performance slurries are for scalable manufacturing of atomically smooth and defect-free polycrystalline silicon carbide (poly-SiC) wafers.

- Industry-leading polishing slurries that can achieve low surface roughness ($R_a < 0.5$ nm) on poly-SiC wafers
- Optimized to work on poly-SiC material with different grain sizes and orientations
- Slurries are high-volume manufacturing (HVM) ready and compatible with bulk delivery systems
- Advanced formulations that provide a low cost of ownership for polishing poly-SiC materials in a wide range of applications from semiconductor to industrial
- Custom solutions are available upon request



RIGID DISK AND MAGNETIC HEAD CMP SLURRIES

There is a growing need for rigid disk and magnetic head slurries in the CMP slurry market.

- Our rigid disk slurries are specially formulated to planarize nickel-phosphorus (Ni-P) and glass substrates to an ultra-low roughness and defects
- Our solutions have enabled the rapid industry-wide transition from high-density PMR disk drives to advanced MAMR/HAMR disk drives that are currently used by leading-edge disk drive customers in high-volume manufacturing
- Our magnetic head slurries are capable of polishing multiple materials in a single step with tunable selectivity to meet stringent surface topography and planarization requirements
- Our products offer multi-material polishing, tunable selectivity, and low defects
- Also includes the Lustra™, Transele™, and Semi-Sperse slurry lines

BARRIER CMP POLISHING SLURRIES

As the focus of barrier CMP shifts away from early process development to yield enhancement and cost of ownership reduction, polishing slurries assume a critical role, influencing both performance and total system cost.

- Our line of i-Cue™ and Sentinel™ slurries for barrier applications are designed to meet our customers' extensive technical requirements

POLISHING SUBSTRATES FOR OPTICAL APPLICATIONS

Our high-performance [Diamond slurries](#) are for scalable polishing of diamond substrates and films.

- Designed to meet various specifications for polishing polycrystalline diamond, monocrystalline diamond, and diamond films in a range of applications
- Slurries are high-volume manufacturing (HVM) ready
- Advanced formulations that provide high polishing rates, up to 10 times faster than conventional processes, while maintaining uniformity, low sub-surface damage, and low defectivity/scratches
- Custom solutions are available upon request
- Also includes DM Series slurry line



GALLIUM AND NITROGEN FACE CMP SLURRIES

Our high-performance [Nitride slurries](#) are for scalable manufacturing of atomically smooth and defect-free nitride surfaces.

- Innovative solutions for bulk polishing, lapping, and CMP of multiple nitride surfaces (GaN, AlGaN, AlN, Ga- or N-face, 'c' or 'm' planes)
- Industry-leading CMP slurries optimized to achieve low surface roughness (<2 angstrom) and low defectivity
- Advanced formulations that provide ultra-high polishing rates up to 10x higher than existing bulk removal processes, while maintaining uniformity, zero sub-surface damage, and low defectivity/scratches
- Custom solutions are available upon request



PROVIDES HIGH FINISHES FOR OPTICAL SURFACES

Our high-performance [Sapphire slurries](#) are for scalable manufacturing of sapphire wafers.

- Designed to meet specifications at various process stages of substrate manufacturing from lapping to CMP for sapphire wafers of orientations, namely C-plane, A-plane, R-plane, etc.
- Optimized solutions that can work on different tool sets and process conditions
- Achieve high removal rates with no sub-surface damage and provide excellent stability and recycling capability
- Enabled with additives, our sapphire slurry
- Custom solutions are available upon request
- Also includes SP Series slurry line



Post-CMP Clean Chemistry

The clean chemistry must be designed to efficiently remove the abrasive slurry particles and organic residue from the wafer. The key to a successful clean is to precisely formulate the clean to the slurry chemistry, considering all the slurry's chemical components, possible chemical reactions, and other contamination sources. The clean should ideally remove all residue that might affect yield while not contributing to contamination.

POST-CMP COPPER CLEANING

Our [PlanarClean® cleaning solution](#) is a post-CMP copper cleaning product designed for use following the barrier CMP step. PlanarClean comes as an aqueous solution with strong-acting agents that are very effective at preventing copper corrosion during and after the cleaning process.

- Designed for use on all CMP platforms
- Delivers excellent organic residue and removal
- Compatible with copper and various dielectric materials



POST-CMP FORMULATED CLEANS

Our [PlanarClean AG formulated solutions](#) are designed for advanced post-CMP processes. The proprietary formulations offer increased performance through enhanced reliability and yield, low-to-zero corrosion or defects, and increased queue time.

- Offer extremely low defectivity
- Provide extended corrosion prevention
- Enable extremely low etch rate of all major substrates
- Meet EHS requirements for fab chemistry



POST-CMP CLEANS FILTRATION

The [Astera™ filter](#) platform is designed for dilute aqueous acids and bases and recommended for post-CMP cleans. Astera polyarylsulfone (PAS) filters enable fast flush-up time and advanced fine particle filtration.

- Advanced retention at all pH levels
- Fast flush-up time to particle baseline enabled by non-surface modified membrane and DI water prewet to minimize filter shedding
- Improved reliability with control of 10 metals including copper and tungsten
- Advanced clean filtration available with Chemlock key for POU housing and 20" cartridge for bulk and facility filtration



POST-CMP CLEANS BULK FILTER HOUSINGS

Our [Chemlock filter housing system](#) saves space while ensuring safer installations and changeouts. This revolutionary new housing locks the cartridge into the bowl, allowing the bowl and cartridge to be removed as a single unit in bulk or chemical/slurry delivery systems (CDS).

- Our Chemlock filter housing system comprises heads, bowls, locking rings, and wrenches all designed to work together to ensure safe operation
- The space-saving, smaller footprint saves a minimum of 8" of vertical space over traditional housing installations
- Lock-in cartridge reduces required overall footprint and perfectly seats the cartridge in head with double O-ring engagement and straight alignment every time
- Molded on fittings and configurations ensure compatibility with most filtration applications
- Virtually hands-free cartridge changeout provides maximum safety and cleanliness while limiting handling of hazardous chemicals



CMP Brushes

The brushes used in post-CMP cleaning should be designed to achieve uniform fluid distribution on the brush surface. Brush materials with a high zeta potential allow the brush surface to repel slurry particles that might otherwise adhere to the brush surface and scratch the wafer.

CMP BRUSHES

[Planarcore® PVA brushes](#) 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 brush core, unlike standard PVA products that are merely friction fitted to the core.

- Molded-through-the-core construction keep PVA dimensionally stable and allows rapid and consistent installation on tools, reducing system downtime
- High-purity PVA dramatically reduces brush break-in and flush-up time
- Close molded technology brush design equilibrates flow through the brush, eliminating the risk of non-repeatable and non-predictable performance
- Advanced brush nodule spiral design enables uniform fluid distribution



CMP Pads

CMP pads are critical in the CMP process to flatten and polish wafers and can have a significant impact on process performance.

Our CMP pad solutions are manufactured using state-of-the-art polyurethane chemistry and engineering advances to provide the exact hardness, pore sizes, compressibility, groove patterns, and window installations needed to meet and exceed the requirements of various CMP applications while providing the lowest cost of ownership.



NEXPLANAR™ PADS

Using thermoset polyurethane technologies, our [NexPlanar pads](#) enable customers to manufacture smaller, faster, and more complex devices.

Element

Serving as a foundation of NexPlanar technology, Element pads are widely used in a variety of CMP applications today.

- Providing choices of hardness and porosity, the Element series has proven success in the semiconductor industry for stable performance and low defectivity

Ultra

The Ultra pad series showcases advances in NexPlanar polyurethane technology beyond what customers already experience with Element pads, and targets advanced nodes requiring superior performance.

- Provides a wide range of tunable hardness, porosity, and compressibility while preserving the low defect advantage of Element pads, breakthroughs in eliminating the trade-offs between high removal rate, planarization, and low defectivity, and the ability to provide improved texture during use to drive higher removal rate and performance stability
- Offers high throughput and low defectivity for a variety of targeted technology applications

MEDEA™ PADS

The [Medea pad series](#) utilizes the performance benefits of the Element product line.

- Provides additional grooving technology, customization, and can be used for both 200 and 300 mm applications

EPIC™ PADS

Our [Epic line](#) of thermoplastic polishing pads offer the optimal balance of best-in-class performance, quality, and cost of ownership.

Epic Power™

[Epic Power](#) thermoplastic polishing pads for SiC wafer polishing.

- Maintain low temperatures during polish for consistent removal rate throughout pad life
- Sizes are available for single wafer and batch wafer polishing platforms and they are the only giant hard pads out there for batch wafer polishing

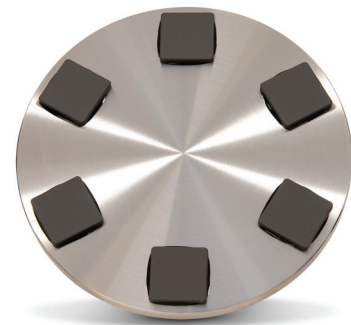
Pad Conditioners

Pad conditioning is a necessary step in the CMP process, allowing the pad surface to maintain the desired roughness so that the removal rate is stable and predictable. An optimally designed conditioner can also extend pad life by increasing the metal removal rate while keeping the pad cut rate relatively low.

DIELECTRIC AND METAL CMP PAD CONDITIONERS

[Planargem® XT CMP pad conditioners](#) with micro-machined silicon carbide (SiC) substrate, offer leading-edge, customer-tailored performance across all aspects of the CMP process. Processed with conformal CVD diamond coating, our pad conditioners deliver long-life, highly uniform pad conditioning while minimizing substrate damage.

- CVD diamond coating eliminates defects caused by lost or broken diamonds
- Tunable SiC features offer performance flexibility to match customer process
- CAD/CAM micro-machined SiC substrate, processed with conformal CVD diamond coating offers superior feature consistency with conditioner life and uniformity improvement including:
 - Pad dressing uniformity
 - Consistent surface roughness and low pad cut rate
 - Targeted disk aggressiveness customized for specific applications
 - Enhanced chemical stability
 - Improved cost of ownership



Fluid Handling System

Contamination must be minimized throughout slurry blending, storage, transport, and handling. As the slurry passes through tubing, valves, and other components of the fluid handling system, it can pick up contaminants. Components made from inert, corrosion-resistant fluoropolymer materials are ideal because they will not shed particles that degrade the slurry.

The abrasive particles in the slurry tend to agglomerate, clumping together to form large particles that cause micro-scratches on the wafer. The larger the scratches and the finer the features on the wafer, the greater the likelihood of killer defects. System designs that minimize dead space where particles can settle reduce the incidence of agglomeration.

We have a proven understanding of fluoropolymer processing and offer the industry's broadest range of carefully developed and fully characterized fluid handling products that are compatible with one another and can more easily optimize the overall design.

FLUOROLINE® ULTRAPURE PFA TUBING

We offer [FluoroLine ultrapure PFA tubing](#) for use in high purity, corrosive CMP environments and where low surface friction is desired.

- Compliant to SEMI Standard F57-0314, the specification for polymer components used in ultrapure water and liquid chemical distribution systems
- Made from high purity PFA material to provide the lowest extractable ionic and organic levels
- An optional ultraclean (UC) extrusion process yields tubing with the lowest total metal extractables and least amount of surface contamination
- Permanently laser marked to allow 100% lot traceability to a specific material lot, production date and production inspection record; custom laser marking is available



PRIMELOCK® TUBE FITTINGS

We have supplied innovative connection technology into the high-purity chemical handling markets for over 30 years. Our extremely robust, clean, [PrimeLock tube fittings](#) perform effectively in the most demanding chemical applications and are the most reliable connection technology on the market.

- The all-PFA wetted construction provides an ultraclean design that enhances reliability
- Clean, robust, and very easy to assemble
- Audible and visual indicators enable users to quickly verify proper connection makeup
- Heat is not required to assemble this fitting, saving time and money
- Available in sizes from ¼" to 1½" and 40 mm



INTEGRA® PLUS WS VALVES

Designed for use with corrosive chemicals, [Integra Plus WS valves](#) excel in ultrapure bulk chemical and CMP slurry applications. The portfolio of manual and pneumatic valves provides a reliable option for dispensing slurry and offers system flexibility and easy installation into any fluid handling system.

- Weir-style (WS) design streamlines the flow path and eliminates dead volume, providing gentle flow while keeping the flow path clean and free from contaminants
- Single-piece diaphragm does not need adhesive and will not separate, increasing reliability in vacuum applications
- PFA and PTFE wetted surfaces provide chemical resistance suitable for use with ultrapure chemicals, slurries, and deionized (DI) water
- A variety of connections including PrimeLock, Flaretek®, "SpaceSaver" and PureBond® provide system flexibility and easy installation into any fluid handling system



Filtration

Regardless of the materials in the system, filtration is critical. Filters should be installed at multiple locations so that they can capture contaminants and agglomerated slurry abrasives before they reach the wafer.

Filtration to remove large particles — those around twice the nominal particle diameter or larger — has long been commonplace in CMP systems. Next-generation filters will be able to remove particles at both ends of the size distribution simultaneously. Extremely small particles, which can introduce underlayer defects, are absorbed onto the filter surface. Larger particles are removed to prevent more traditional microscratch defects.

POINT OF DISPENSE SLURRY FILTRATION

[Planarcap® APR and NMB point-of-dispense slurry filters](#)

Increase operational efficiency with strategic installation at the final dispense point just before the slurry contacts the wafer.

- APR filter technology removes ultrafine abrasives to reduce underlayer defects. The additional absorption ability can remove fine particles and mitigate inadequate post-CMP cleans
- NMB (nano continuous melt blown) technology effectively removes large abrasives, agglomerates, and gels to reduce micro-scratches and extend filter lifetime. The large gradient design can maximize particle-loading capacity and reduce face-velocity due to increased media porosity, providing long-lasting filter performance without compromising filter retention performance



POINT-OF-TOOL SLURRY FILTRATION

[Solaris APR and NMB CMP slurry filters](#) and [Solaris II manifolds](#)

are designed for optimum gel removal and media-specific particle and agglomerate retention in the most demanding CMP slurry applications.

- APR filter technology removes ultrafine abrasives to reduce underlayer defects. The additional absorption ability of the multilayer media removes fine particles and mitigates inadequate post-CMP cleans
- NMB filter technology more effectively removes large abrasives, agglomerates, and gels to reduce micro-scratches and extend filter lifetime with a gradient media design
- The filter self-venting filtration eliminates dead space and potential for slurry dry-out in the filtration media, ensuring longer life
- Our Solaris II manifold with Connectology® technology allows easy installation or retrofit of Solaris filtration technology in point-of-use CMP applications



BULK AND FACILITY CMP SLURRY FILTRATION

Our extensive CMP process knowledge and product innovation focus enabled the development of [Planargard® APR CMP slurry filters](#) and [Planargard NMB CMP slurry filters](#) to target defect reduction for BSM (bulk slurry manufacturing) and facility applications.

- The APR filter multilayer media design absorbs fine abrasives to reduce underlayer defects and minimize inefficient post-CMP cleans, increasing overall cost of ownership
- The NMB gradient media design removes large abrasives, agglomerates, and gels with a depth media structure for improved flow path and low shear filtration
- Our [Chemlock® filter housing](#) provides space saving, clean, and easy installation



BULK AND FACILITY CMP FILTER HOUSINGS

Our [Chemlock filter housing system](#) saves space while ensuring safer installations and changeouts. This revolutionary new housing locks the cartridge into the bowl, allowing the bowl and cartridge to be removed as a single unit in bulk or CDS (chemical/slurry delivery systems).

- Our Chemlock filter housing system comprises heads, bowls, locking rings, and wrenches all designed to work together to ensure safe operation
- Lock-in cartridge reduces required overall footprint and perfectly seats the cartridge in head with double O-ring engagement and straight alignment every time
- The space-saving, smaller footprint saves a minimum of 8" of vertical space over traditional housing installations
- Molded on fittings and configurations ensure compatibility with most filtration applications
- Virtually hands-free cartridge changeout provides maximum safety and cleanliness while limiting handling of hazardous chemicals



Process Monitoring

While choices of materials, chemicals, and components can improve CMP outcomes, it is also necessary to measure process parameters including particle size, flow rate, and chemical concentrations. Measurements in the lab inform design, while online monitoring at the fab provides real-time feedback that makes it easier to maintain process stability and keep yield high.

PARTICLE CHARACTERIZATION

In advanced node CMP applications, automating the monitoring process can help prevent costly yield excursions. Advanced particle count and size analyzers provide high resolution and accuracy in CMP slurries and other suspensions.

SINGLE PARTICLE OPTICAL SIZING (SPOS) TECHNOLOGY

Installed downstream from filters, our [AccuSizer® SPOS system](#) provides data to inform real-time decisions that will optimize the CMP delivery process. Proactive monitoring enables action before conditions impact yield.

- Proven SPOS technology allows users to individually size and count particles in CMP slurries over a wide range with unprecedented accuracy
- Continuously monitors large particle counts (LPC) in CMP slurry delivery systems and helps optimize filtration and other process conditions
- Available in Mini LE, FX, and FX-Nano configurations to meet the unique needs of your CMP slurry characteristics
- Solutions available for ceria CMP slurries, silica CMP slurries, and for clean, colloidal CMP slurries



DYNAMIC LIGHT SCATTERING (DLS) TECHNOLOGY

The [Nicomp® N3000 DLS online system](#) can be integrated into many nanoparticle processes, providing real-time particle size distributions.

- This online system couples a compact optics bench with our unique autodilution fluidics, all rugged enough for the production environment
- Provides high resolution, particle size, and zeta potential measurements
- Special trending graphs in the software can be used to set out-of-control limits that will signal operations when the end point is reached
- The system is small enough to be integrated with many nanoparticle processes, providing real-time particle size distributions



PROCESS CONTROL

To achieve high product yield, process control is needed to help ensure proper slurry blending ratios and to check whether the fluid handling system is allowing sufficient flow.

FLOW CONTROL

Our [InVue® integrated flow controller, model NT6520](#) combines differential pressure flow measurement technology and advanced closed-loop process control to enable precise point-of-use slurry flow control.

- Designed for point-of-use slurry blending and dispense applications requiring medium to high flow rates (2.5 to 40 L/min)
- Is the most accurate flow control technology in bubble prone media versus other commonly used technologies
- Integral pressure transducer provides simultaneous flow and pressure output
- Compact, space-saving footprint enables easy field installation
- Provides high repeatability, allowing superior process control



PROPORTIONAL CONTROL VALVE

Our [NT™ proportional control valve, model 6300](#) provides reliable, linear proportional control in ultra high-purity and CMP slurry applications. With the latest motor driver technology, the internal electronics control all aspects of the valve's stepper motor.

- PTFE wetted surfaces offer high-purity and corrosion resistance
- Available in 0.16, 0.68, 1.0 and 2.80 Cv flow factor
- Double diaphragm construction prevents chemical exposure to motor containment and protects from contamination
- The valve is actuated using our advanced algorithm design to maintain the desired setpoint
- Optimized seat and diaphragm design minimize dead volume and fluid shear, allowing reliable control from fully closed to fully open
- Compact footprint enables easy installation where space is limited



PROCESS MEASUREMENT

Our portfolio of process measurement solutions is specifically designed for use in high-purity, harsh chemical environments. Our electronic flowmeters allow users to obtain greater control of process variables and leading-edge pressure transducers measure line pressure accurately and reliably.

ELECTRONIC FLOWMETER

Our [InVue electronic flowmeter, model NT4400](#) simultaneously measure flow rate and outlet pressure throughout the system, allowing for greater control of process variables.

- No moving parts to generate particles
- Nonmetallic sensing technology for reliable measurement
- Integral pressure transducer allows additional process information
- Flow-through design minimizes dead volume
- 1% full scale accuracy for critical measurements
- Easy installation in any orientation



PRESSURE MEASUREMENT

Our flow-through [NT pressure transducer, model 4210](#) combines the latest electronic sensing technology with high-purity materials to provide accurate and reliable line pressure measurement that allows for greater control of CMP process variables.

- Provides reliable pressure measurement in corrosive chemical, CMP slurry, and high-purity applications
- 100% functionally tested prior to shipment with accuracy of 1% of full scale
- No moving parts or fill fluids reduce contamination potential
- The flow-through design minimizes dead volume, reducing contamination potential



CHEMICAL CONCENTRATION MONITORS

[SemiChem advanced process monitor \(APM\)](#) is a wet chemical monitoring system that automatically samples, analyzes, and reports quantitative chemical concentration of critical processes, helping to increase product yields.

- Proven electrochemical techniques provide class-leading chemical concentration data allowing the slurry distribution system to deliver exact concentration
- Online, near real time platform detects process excursions in volatile chemistries, preventing loss of product quality
- Transitions the lab technology to the process, allowing fast and accurate process control
- Provides the industry's most precise monitoring available to maintain process chemical composition and integrity
- Rugged, industrial design maintains a mean time between failures (MTBF) >8500 hours



IN-LINE PROCESS MONITORING

The [InVue GV148 concentration monitor](#) serves as a pre-check or early warning system to verify whether the slurry still meets specifications and unwanted variability has not been introduced throughout its use.

- Uses index of Refection for measurement of CMP slurries and nonconductive fluids such as H_2O_2
- Small footprint with integral electronics minimizes tool size
- HMI software enables real-time data logging, analysis, and customization
- Optional in situ window cleaning port provides easy access to sapphire window for cleaning, minimizing maintenance downtime



Putting it All Together

When the entire system works in sync, contamination decreases and fabs are best able to achieve their yield goals for the CMP process. The more stringent the performance requirements, the more important it is for all aspects of the CMP system to support the slurry. Sourcing the slurries, components, filters, chemistries, conditioners, brushes, and monitoring tools from Entegris, a single supplier, delivers the best on-wafer performance, decreases cost of ownership, and ensures high yield.

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 less room for error, process optimization of CMP slurries and chemistries is necessary to achieve desired yields.

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. Entegris is well positioned to provide the materials, components, and systems that help reduce the risk of defects and improve overall process yield.



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

- Component life cycle testing in slurry
- Component impact on slurry health
- Particle testing
- Flow rate optimization
- Ion chromatography
- Failure analysis

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.

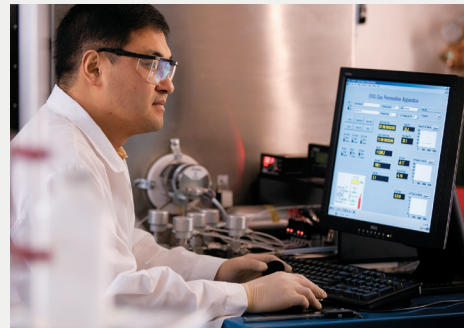
We are committed to applying these principles to product stewardship, environmental protection, employee health and safety, and plant security.

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 CMP processes and developing solutions to ensure tight control over slurry and formulated chemistries. Tight control over materials, components, and systems help achieve the desired removal rates and minimize CMP-induced defects.

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.

LIMITED WARRANTY

Entegris' products are subject to the Entegris, Inc. General Limited Warranty. To view and print this information, visit [entegris.com](https://www.entegris.com) and select the [Legal & Trademark Notices](#) link in the footer. Entegris does not warranty any failure in the case of customers using unapproved foreign components.

FOR MORE INFORMATION

Please call your Regional Customer Service Center today to learn what Entegris can do for you. Visit [entegris.com](https://www.entegris.com) and select the [Contact Us](#) link to find the customer service center nearest you.

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