# DuPont™ Teflon®

fluoropolymer resin

## Meeting Semiconductor Needs for Cleanliness and Reliability

### DuPont™ *Teflon*® Product Line at a Glance

DuPont™ *Teflon*® fluoropolymer resins are proven materials of choice for components in etching and cleaning equipment and related fluid transport systems. Their exceptional chemical resistance helps prevent contamination of process fluids and extend equipment service life.

Only DuPont makes *Teflon*®. To be sure you'll get the performance benefits available with DuPont fluoropolymers, specify them by name. The *Teflon*® Diamond Mark on packaging assures you that components and equipment are made with DuPont *Teflon*® fluoropolymer resins.

***Teflon*® PFA HP *Plus*:** A fully fluorinated fluoropolymer developed to meet industry demands for durable components and piping with high purity and low extractables to improve yields for devices with very small features. Compared with earlier types of PFA, *Teflon*® PFA HP *Plus* offers unsurpassed purity, longer life under dynamic loads, improved resistance to stress cracking caused by fluorosurfactants, lower permeation by HCl and smoother surfaces that resist microbial contamination. The fully fluorinated polymer chain end groups help provide superior protection against ionic and metallic contamination, and attack by ozonated fluids. Semiconductor industry applications include piping, fittings, valves and other components for transporting aggressive, ultrapure fluids; wafer carriers; linings for tanks and vessels; sinks for wet benches; fluid containers; and labware.

***Teflon*® PFA HP:** A fully fluorinated polymer specifically tailored to meet the semiconductor industry's needs for high purity and minimium extractables for the most demanding uses. Components of *Teflon*® PFA HP have superior resistance to environmental stress cracking. *Teflon*® PFA HP is unaffected by virtually all chemicals and solvents. Components are fabricated with efficient, versatile thermoplastic melt extrusion, and injection, transfer, and rotational molding. Semiconductor industry applications include piping, fittings, valves, and other components for transporting aggressive, ultrapure fluids; wafer carriers; linings for storage tanks and vessels; sinks for wet benches; fluid containers; and labware. *Teflon*® PFA HP is available as PFA 440 HP, PFA 445 HP, and PFA 450 HP.

***Teflon*® PTFE:** The original fluoropolymer resin discovered by DuPont in 1938. Supplied as granular powders and aqueous dispersions. *Teflon*® PTFE is unaffected by virtually all chemicals and solvents. Shapes and parts are formed by specialized processing technologies, typically compression molding and sintering followed by machining. Tubing is made by ram extrusion. Linings are formed by isostatic molding and sintering or applied as sheets. Surfaces are coated by applying dispersion and then baking. Processing has a much stronger effect on performance of parts of *Teflon*® PTFE than for most other polymers. Semiconductor industry applications include pipe liners, fittings, valves, pumps, and other components used for transferring aggressive, ultrapure fluids.



The miracles of science®

***Teflon*® NXT:** A chemically modified *Teflon*® PTFE available in granular powder grades. Developed to provide higher permeation resistance, lower creep, longer flex life, smoother surfaces, and more versatile processing than *Teflon*® PTFE. *Teflon*® NXT is unaffected by virtually all chemicals and solvents. Fabrication is accomplished by the same compression molding and sintering processes as *Teflon*® PTFE. In addition, to reduce the need for machining, parts of *Teflon*® NXT can be cost-effectively assembled by heat welding under moderate pressure and shaped by thermoforming. *Teflon*® NXT is used in the same semiconductor industry applications as *Teflon*® PTFE.

***Teflon*® AF:** A family of amorphous fluoropolymers available in pellets. Compared with other *Teflon*® resins, *Teflon*® AF has higher strength and creep resistance, superior optical clarity, solubility in selected solvents, higher gas permeability, higher compressibility, and lower thermal conductivity and dielectric constant. Like other *Teflon*® resins, it is unaffected by nearly all chemicals and solvents. Fabrication is by compression molding, melt extrusion, or injection molding. In addition, thin films and coatings are made by spin coating with solutions. Semiconductor industry applications include dielectric and passivation coatings for integrated circuits.

**Tefzel® ETFE:** A partially fluorinated thermoplastic fluoropolymer that is tougher, stiffer, and harder than the *Teflon*® fluoropolymers. Supplied as pellets and powder. *Tefzel*® ETFE is used in less demanding applications where its temperature and chemical resistance are satisfactory. Its chemical resistance approaches that of *Teflon*®. Components are made using conventional melt extrusion and injection, compression, transfer, and blow molding processes. Powder is rotationally molded to form linings and used to coat metal. Semiconductor industry applications include vessel and tank linings, fluid handling components where superior mechanical properties are useful and chemical and temperature resistance are satisfactory.

# Typical Semiconductor Industry Applications for DuPont Fluoropolymers

## *High-Purity Bulk Chemical Systems*

Bulk chemical distribution (BCD) reduces costs for delivering chemicals from large bulk containers to use points. Systems often include automated equipment for diluting and dispensing chemicals. *Teflon*® is widely used in BCD components to help protect fluid purity.

**Piping:** Piping of highly pure, chemically resistant *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* helps prevent contamination of ultrapure fluids. Piping can be joined by thermal welding or with flare-type connections. Dual containment constructions are available for added protection against leaks and contamination.

**Tanks and containers:** *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE are used to line or form tanks and containers for storing and dispensing ultrapure and aggressive chemical fluids. Suppliers can deliver chemicals in returnable drums lined with *Teflon*®. For applications involving pressure, metal or reinforced-plastic tanks can be lined with *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. *Teflon*® resins are compatible with virtually all chemicals to help protect fluid purity.

**Fluid-handling components:** BCD system piping is connected with fittings of *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. Typical systems use pumps, pressure regulators, and valves, and automated systems require valves that can be remotely actuated. These components are available with all wetted surfaces made from *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE to provide the required high level of protection against contamination.

**Filters:** For removing particulate from fluids, *Teflon*® PTFE is used as a filter medium where extremely high chemical resistance and purity are required. *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* is used for chemically resistant, high-purity filter housings.

**Sensors:** For BCD systems, capacitive-type sensors shielded in dip tubes of high-purity *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* monitor fluid levels in tanks. Other designs can sense through walls of tanks or pipe made from *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. Connecting electrical cables are jacketed with *Teflon*® PFA for additional protection against contamination.

## *Wet Etching, Stripping, and Cleaning*

In wet processing, wafers are cleaned and etched, and then cleaned of photoresist and residuals from the etching process. Components of *Teflon*® are used in tools and fluid delivery systems to help prevent contamination.

**Piping:** For deionized (DI) water and chemicals, piping of highly pure *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* helps prevent the introduction of contaminants. Piping can be joined by thermal welding or with flare-type connections.

**Fluid-handling components:** Valves, fittings, and pumps with all wetted surfaces made from *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE provide a high level of protection against contamination.

**Baths and sinks:** These tool components are made from or lined with *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE to help prevent contamination of process fluids and wafers. *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* can be efficiently molded to form components. Components of *Teflon*® are much more resistant to breaking than quartz components.

**Wafer carriers:** *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* is molded to form carriers for supporting wafers during wet processing. Its chemical resistance and high purity help prevent contamination of wafers that could reduce yields.

**Tanks and containers:** *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE are used to line or form tanks and containers of many sizes for storing and dispensing ultrapure and aggressive chemical fluids. For applications involving pressure, tanks of metal or reinforced plastic may be lined with *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. *Teflon*® resins are compatible with virtually all chemicals to help protect fluid purity.

**Sensors:** Capacitive-type sensors shielded in dip tubes of high-purity *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* monitor fluid levels in tanks. Other designs can sense through walls of tanks or pipe made from *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. Connecting electrical cables are jacketed with *Teflon*® PFA for additional protection against contamination.

**Filters:** For removing particulate from liquids and gases, *Teflon*® PTFE is used as a filter medium. *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* is used for filter housings.

## *CMP*

Chemical mechanical planarization (CMP) levels wafer surfaces before vapor deposition and subsequent processing steps. The working fluid is a slurry of fine abrasive particles, chemicals, and water. In CMP, components made with *Teflon*® help guard against contamination of process fluids and slurries that come in contact with wafers.

**Piping:** For slurries and DI water, piping of highly pure *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* helps prevent the introduction of contaminants. Piping can be joined by thermal welding or with flare-type connections. *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* is compatible with chemically aggressive DI water used for dilution and washing.

**Fluid-handling components:** Valves, fittings, and pumps with all wetted surfaces made from *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE provide a high level of protection against contamination.

**Sensors and flowmeters:** Flowmeters indicate fluid flow rates. Capacitive-type sensors shielded in dip tubes of high-purity *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* monitor fluid levels in tanks. Other designs can sense through walls of tanks or pipe made from *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. Connecting cables are jacketed with *Teflon*® PFA for additional protection against contamination.

## *Analytical*

Analyses of process fluid composition, determinations of particulate and bacterial levels, and other laboratory procedures are critical steps in manufacturing semiconductors. Fluid chemistries must be analyzed and kept on specification to maintain yields. For accuracy and repeatability, labware and equipment must not react with or contaminate the samples being studied or the reagents.

**Containers:** Reagents for analytical work, as well as process fluid samples, are held in containers of *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* for protection against contamination. Because *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* is unaffected by virtually all chemicals and solvents, containers may be reused time after time.

**Tubing:** Apparatus for wet analytical analyses may be interconnected with tubing of *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* to help prevent contamination and assure test accuracy.

**Labware:** A full range of beakers and other lab equipment is available in *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. The resin's chemical resistance and purity help prevent inaccurate analyses.

**Filters:** Filters for lab-scale purification and clarification of gases and liquids have membranes of *Teflon*® PTFE. Because it has broad chemical resistance, *Teflon*® PTFE helps prevent contamination of fluids.

## *High Purity Chemical Manufacturing*

High-purity chemicals and solvents used in the semiconductor industry are manufactured using equipment that resists corrosion and leaching that can introduce contaminates. It is often more cost effective to make products that are inherently pure rather than trying to achieve high purity through refining steps. To guard purity, the chemical process industry (CPI) uses the same types of corrosion-resistant fluid handling components as the semiconductor industry.

**Process vessels:** Vessels and columns for reactions, distillations, absorptions, and other processes can be made of steel or reinforced plastic lined with *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE. Such linings are used by the CPI because they extend service life and reduce maintenance, with the added benefit of protecting product purity.

**Pipe and fittings:** Steel or reinforced plastic pipe is lined with *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE is used for transporting ultrapure fluids. Lined fittings are used to complete piping systems. Connections are made with bolted flanges or by melt bonding with *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. To reduce the number of flanged fittings in a system, piping is bent to the required configuration after lining.

**Tubing:** Tubing of *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* is used instead of lined pipe for transporting chemicals when its smaller diameter is sufficient.

**Valves and pumps:** A wide range of valves, pumps, and other fluid handling components are available with linings of *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE. Like lined pipe, these components are used by the CPI to extend service life and reduce maintenance, with the added benefit of protecting product purity.

**Storage containers:** Linings of *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* or *Teflon*® PTFE are used in steel and reinforced- plastic tanks to help protect the purity of stored materials.

**Transport containers:** Containers for shipping high-purity chemicals and solvents are lined with *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* to protect their purity. Such containers are reusable, because the lining is unaffected by contact with virtually all chemicals.

**Filters:** Filters with media of *Teflon*® PTFE are used to remove particulate from high-purity chemicals and solvents. These filters are similar to those used in semiconductor manufacturing processes but may have higher capacity.

**Sensors:** To help prevent contamination, capacitive-type sensors shielded in dip tubes of high-purity *Teflon*® PFA HP or *Teflon*® PFA HP *Plus* monitor fluid levels in tanks. Other designs can sense through linings of tanks or pipe made from *Teflon*® PFA HP or *Teflon*® PFA HP *Plus*. Connecting cables are jacketed with *Teflon*® PFA for additional protection against contamination.

For more information, visit our Web site at **www.*Teflon*.com/semiconductor**, or call us at (800) 207-0756, and we'll be happy to answer your questions about *Teflon*®.

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