CARDINAL UHP

an O'BRIEN company

setting a new course

Since 1983 Cardinal UHP has been supplying the semiconductor industry with piping components that help increase manufacturing efficiency. We introduced many practices that are standard operating procedure throughout the industry today. Cardinal UHP was the first to offer top quality electropolished fittings, piping components, and signed certification to our customers, guaranteeing specified quality levels in our products. Much of our early efforts are still reflected in current SEMI standards.

Today we continue to supply the finest in ultra high purity fittings and piping components to semiconductor manufacturers and industries requiring critical ultra high purity production systems. We also supply a wide range of tubing for vacuum, oxygen, bio-pharmaceutical, and medical gas service.

In today's market it is not enough to provide excellent products; we must provide them at a good value. O'Brien Corporation's recent acquisition of Cardinal UHP added 40 years of engineering and manufacturing expertise. Cardinal UHP is setting a new course. A new state-of-the-art manufacturing facility in St. Louis Missouri combines the latest in automated electropolishing technology with our ISO 9002 registered quality program. We continue to invest in research and development, examining the methods for controlling variables in the electropolishing process.

We believe that the more you know about O'Brien Corporation and Cardinal UHP the more you'll want ultra high purity tubing and fittings from Cardinal UHP.

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from concept to reality

Our ISO 9002 quality system begins with the specifications for raw materials and continues through to packaging, delivery and support of the finished product.

It starts with a finished product specification. Not all processes require the same level of cleanliness and surface finish. To meet customer needs Cardinal UHP offers products to a variety of material and finish specifications with various levels of documentation.

Raw material specifications (tighter than industry standards) are developed to provide the lowest cost product that meets or exceeds the finish and elemental specification.

Upon receipt of materials extensive inspection insures a finished product that meets required specifications.

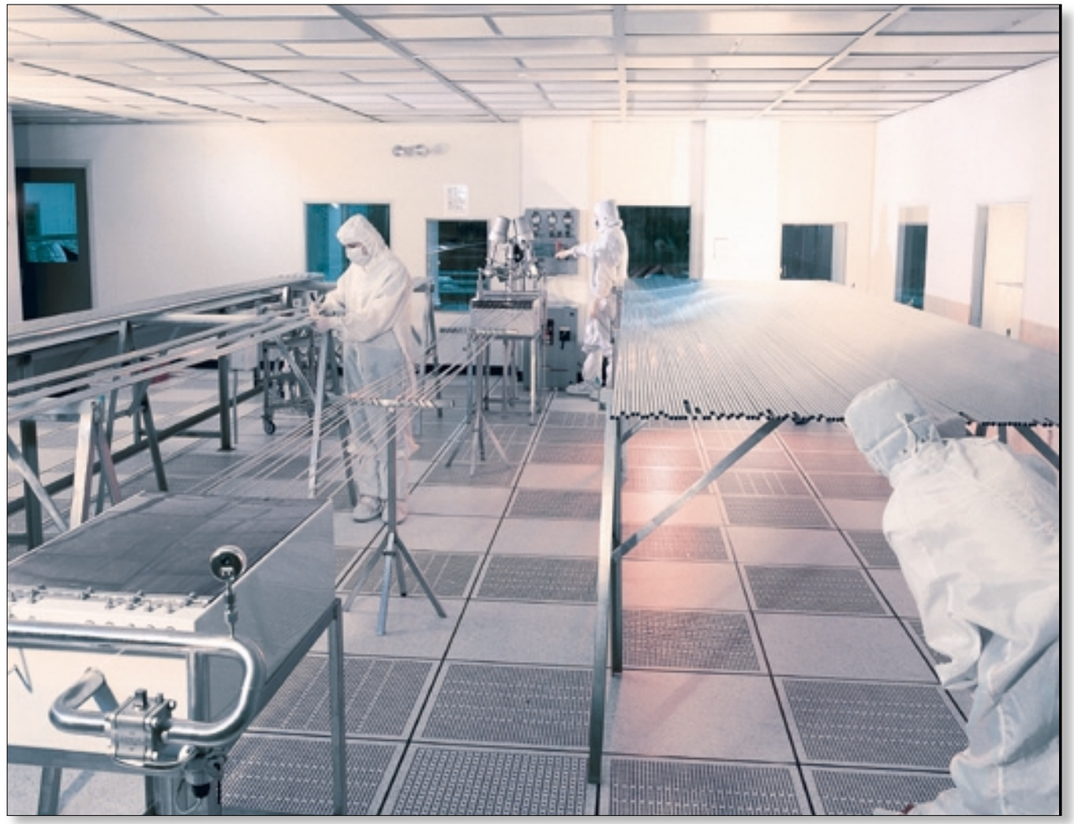
Mechanically polishing fittings after bending and welding provides an excellent base for the final electropolishing and passivation steps.

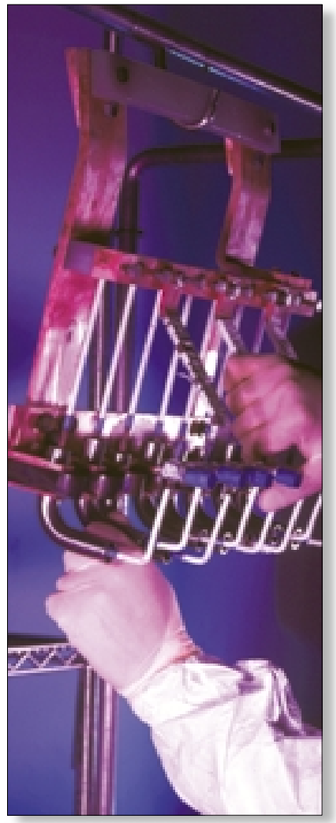
Electropolishing is the key to providing a smooth, clean and chromium enriched corrosion resistant surface.

Chemical passivation of the tube and fittings further enhances the corrosion resistance of the finished component.

Final cleaning and packaging are done in our Class 10 clean room with heated 18 megohm-cm DI water. Parts are then dried and bagged to protect them until you are ready to use them.

Besides producing our cataloged tubing and fittings we also provide cleaning, passivation and electropolishing services to other manufacturers of specialty equipment.





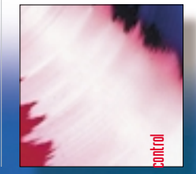
research & development

As part of our extensive ongoing research and development programs Cardinal UHP has funded metallurgy research at the University of Missouri's Center for Materials Research. Surface treatment studies have focused on developing increased standardization in the electropolishing process in order to achieve a more predictable and consistent finished product. Two areas that have been targeted to date are the variables involved in the process and the effect that raw materials have on the final product.

The knowledge gained through our R&D efforts led to the creation of the first ALC-300 digitally controlled electropolish process monitoring equipment capable of producing consistent quality products without variance from operator to operator.

Through our research, we have come to understand that many inconsistencies in the final product are directly attributed to variation in the microchemistry and grain size of the raw material. This is why we take special care to procure only materials providing optimal conditions for electropolishing.

Today we have improved on the industrial specifications for raw stainless steel alloy, establishing our own proprietary standards for material procurement. Our continuing investigation of the effects of process variables allows Cardinal UHP to transform the art of electropolishing into a controlled science.



the raw material

Although traditional tubing materials like copper are adequate for some high purity applications, the material of choice in the semiconductor and bio-pharmaceutical markets is 316L stainless steel.

Readily available, 316L is a low carbon steel alloy, attractive because of its good weldability and inherent corrosion resistance. However, 316L may contain impurities in the form of trapped gases and non-metallic inclusions. To prevent this from becoming a problem for our customer, we select only specific grades of 316L and purchase materials to our own specifications.

Cardinal UHP produces ultra high purity tubing from many materials besides 316L. For example, we also use 304SS, Hastelloy, Monel, and copper. Prior to placing any material in production we test representative samples to determine their wall thickness, ovality, weldability and compatibility with our electropolishing process and desired RA finish.

mechanical polishing

Mechanical polishing uses abrasive materials to reduce surface irregularities. Although it smoothes the surface, sometimes mechanical polishing is not enough.

All fittings are chemically passivated after fabrication and mechanical polishing to restore the passive layer of the original base material. Depending upon the specification, fittings are also electropolished to further reduce surface roughness and improve corrosion resistance.

passivation

Passivation is a process that dissolves the free iron particles present following forming, machining, and electropolishing processes. This is accomplished by bathing the material in a heated solution of nitric acid. If the particles are allowed to remain they can attach themselves to the base material, eventually oxidizing and contaminating your system.

When used in conjunction with our proven electropolishing process, passivation improves upon the original corrosion resistance of the alloy. Material performance is dramatically improved by the formation of a thick chromium enriched oxide layer.

distribution

Cardinal UHP has a worldwide network of responsive, knowledgeable sales and service personnel who are thoroughly trained to analyze your situation and deliver the products and services to fit your needs.

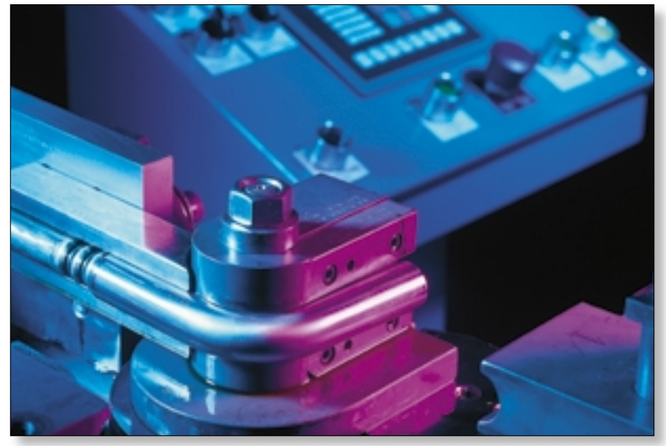
With our central warehouse located in St. Louis, Missouri and our international distribution points, we have the capability of delivering our products promptly and efficiently to any destination in the world.

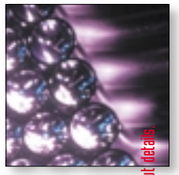
coaxial/dual containment tubing

Cardinal UHP coaxial dual containment tubing and fittings provide safe distribution of volatile or toxic gases. In the unlikely event of a leak in the process tube the hazardous gas/fluid is contained by the outer tube and evacuated for safe disposal.

Process tubes are provided with the same surface finish and specifications as our single wall tube and fittings. We have a full range of coaxial fittings (a fitting-within-a-fitting) such as elbows, starter fittings, sensor hookups, and reducing and branching tees.

Cardinal UHP created a specially designed spacer between the process and containment tube to maintain a consistent annular space and eliminate excess vibration. The spacer supports also reduce pipe noise and provide continuous positive electrical contact where static discharge poses potential hazards.





It's about details.

It's about safety

fittings

Fittings are formed from material that meets the same exacting standards as our process tubing. We begin the process with a heavier wall to offset the thinning that occurs during manufacturing. Cardinal UHP fittings undergo a thorough preparation process to insure corrosion resistance as well as stringent dimensional specifications for economical installation.

First, welds are mechanically polished, and when required, fittings are electropolished and passivated. All welds are 100% visually inspected and mass spectrometer helium leak tested to $1x\ 10^{-9}$ cc/sec. Finally, the fittings are cleaned, capped, and bagged to meet the required specification.

electropolishing

Electropolishing creates a smooth clean surface that enhances corrosion resistance and reduces particle entrapment in microscopic crevices. With our innovative and proprietary ALC-300 process, Cardinal UHP greatly increases the ability to deliver quality electropolished components for dependable performance in any critical gas distribution system.

It's about quality.

The Cardinal UHP system creates a leveling action so effective that an electropolished surface often has only one tenth the surface area of a mechanically or chemically polished surface. During the electropolishing process the wall thickness is carefully monitored, ensuring excellent weldability with all automatic welding equipment.

Our ALC-300 controller uses statistical process control to bring the electropolishing process into the twenty-first century. Every vital parameter is monitored and regulated with this innovative computer controlled system. Since process parameters are stored in a database, the ultimate in material tracking is available.

services

services

Cardinal UHP provides specialized services such as electropolishing, passivation, cleaning and bagging of materials supplied by our customers. These services can be provided on an as needed or contract basis. If you need one piece or thousands of pieces Cardinal UHP can help.

Electropolishing

With our carefully regulated and automated electropolishing process, we can provide surface levels of less than 5 Ra. When electropolishing customer supplied material we can often provide a surface twice as smooth as received. Our in-house capabilities accommodate a wide variety of products including tanks, valve and regulator bodies, specialty fittings, filter housings, pipe and tubing, manifolds, heat exchangers and pump casings.

Passivation

Nitric acid passivation provides improved corrosion resistance, even if the part is not electropolished. We control pH, temperature, flow, suspended contaminants, and time in our passivation process to maximize the effectiveness of the passivated finished part. We can effectively passivate a wide variety of products including long lengths of coiled tubing.

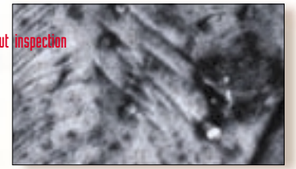
Cleaning and Bagging

Cardinal UHP offers a range of cleaning services including cleaning for oxygen service and specialized cleaning to customer specifications requiring solvent and heated deionized water processing. In addition to providing cleaning services we also provide packaging services such as capping, bagging, double bagging and sealing in a clean room environment – certified according to ISO and Federal Standard #209 as class 10.

Fabrication/Machining/Welding

Our experienced craftsmen and engineers can design and fabricate components to your specifications including special fittings, gas manifolds, face seal fittings, containment systems, and pipe-to-tubing transitions. With the capability to work with most metals including stainless steel, Hastelloy, Monel, tantalum, titanium, aluminum, and copper, Cardinal UHP can design and fabricate your high purity system components.

It's about inspection



It's about commitment

quality assurance

quality assurance

Cardinal UHP was the first company in the high purity tubing and fitting industry to be registered to ISO 9002 by National Quality Assurance. Our unyielding commitment to quality is evident in every step of our manufacturing process. From the start of procurement we specify stringent material standards. When raw materials arrive at our loading dock they are quarantined until wall thickness, ovality, smoothness, surface morphology, and chemical composition have been verified to insure it will meet our rigorous electropolishing procedures.

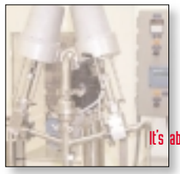
All measuring instruments and analytical equipment are calibrated and traceable to NIST standards. Finally, every employee is empowered to declare piping and fittings unfit for sale if deviations from our standards are discovered.

Before packaging all tubing and fittings are cleaned with 60°C 18 megohm-cm deionized water — produced through a reverse osmosis deionized process, surpassing SEMI guidelines for pure water. Components are then purged with 100°C dry, high purity nitrogen filtered through a 0.005 micron absolute filter. Finally, color-coded caps are placed over a non-permeable nylon film and the finished product is sealed in single or double poly bags. The final cleaning and packaging is done in our Class 10 clean room.

Fittings and tubing are not only inspected visually, but stylus measurement devices and mass spectrometer helium leak detectors are utilized. Additionally, the following quality assurance options are available:

- Scanning Electron Microscope (SEM) photographs
- Auger Electron Spectroscopy (AES) tests
- Electron Spectroscopy Chemical Analysis (ESCA) tests
- Testing for presence of moisture utilizing a Meeco Aquamatic Plus moisture analyzer
- Scanning Tunneling Microscope (STM) surface analysis tests
- Testing for presence of particles down to 0.01 micron utilizing a MET1CNC particle counter
- Certification for oxygen and medical gas service
- Image processing (video probe and/or boroscoping capabilities)

With Cardinal UHP tubing and fittings, you can be sure that you are installing cleaner components so your process can be brought on line more quickly and efficiently.



It's about innovation.

ultra high purity

ultra high

product classifications

tech 100

- Electropolished to Ra 5µin / 0.13µm.
- Produced from low manganese seamless VAR tubing meeting the most stringent ASTM requirements.
- Subject to numerous quality tests including Auger, SEM and ESCA.
- Hot DI cleaned (60°C), purged with 100°C filtered nitrogen, capped, and double bagged in a Class 10 clean room.

tech 50

- Electropolished to Ra 7µin / 0.18µm.
- Produced from high quality 316L seamless and welded stainless steel.
- Produced to meet current ASTM standards.
- Subject to numerous quality tests including Auger, SEM and ESCA.
- Cleaned with 60°C DI water, purged with 100°C filtered nitrogen, capped, individually double bagged and then bulk bagged in a Class 10 clean room.

tech 25

- Electropolished to Ra 8µin / 0.20µm.
- Produced from high quality 316L seamless and welded stainless steel.
- Produced to meet current ASTM standards.
- Cleaned with DI 60°C water, purged with 100°C filtered nitrogen, capped, individually double bagged and then bulk bagged in a Class 10 clean room.

TG-22

- Surface roughness of 20µin / 0.50µm.
- Produced from Hastelloy C-22 which is resistant to pitting and crevice corrosion.
- Chemically passivated in a heated nitric acid bath followed by a 60°C DI rinse.
- Nitrogen purged, dried, capped and bagged in a Class 10 clean room.
- Used for the distribution and transfer of corrosive gases in high purity gas systems.

tech 20

- Surface roughness of 15µin / 0.38µm.
- Non-electropolished high quality 316L seamless and welded stainless steel.
- Chemically passivated.
- Cleaned with heated 18 megohm-cm DI water and purged with filtered nitrogen in a Class 1000 clean room.
- Used in general purity gas distribution systems, such as compressed dry air, nitrogen lines, argon and other bulk inert gas services.

tech 10

- Surface roughness of 25µin / 0.63µm.
- Non-electropolished high quality 316L seamless and welded stainless steel.
- Solvent cleaned, purged with nitrogen, capped, and individually bagged.
- Passivated and rinsed with DI water.
- Used in analyzer sample lines, O_2 piping (CFOS), medical gas piping, and vent lines.

tech 5

- Surface roughness of 40µin / 1.0µm.
- Non-electropolished high quality 316L seamless and welded stainless steel.
- Solvent cleaned, purged with nitrogen, capped, and individually bagged.
- Used for instrumentation and non-critical gasses.

Specifications subject to change without notice.

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