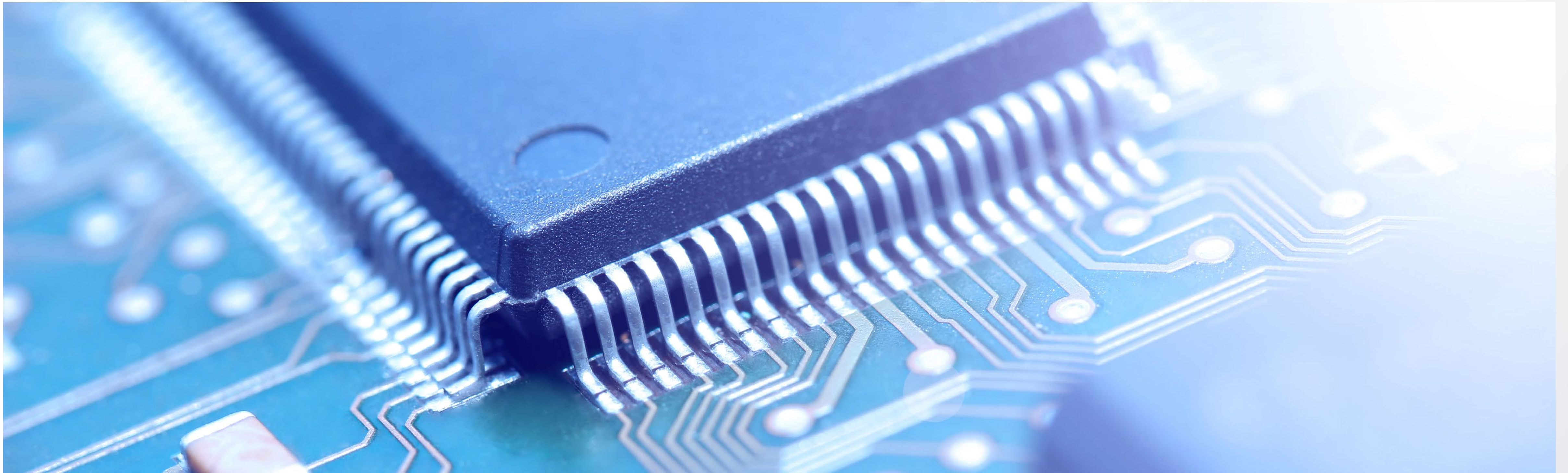


# Cleanliness Chain

When it comes to semiconductor manufacturing, you need to know that every supplier process, from raw materials selection to final inspection of installed components, is designed to get you from source to exhaust with maximum cleanliness and no contamination. And how you get there is the Swagelok difference.







## How Are We Different?

Cleanliness starts with our commitment to ultrahigh-purity materials, followed by our manufacturing processes, cleaning specifications, and quality control procedures. With these tools, you can trust Swagelok to provide the products you need so you can manufacture products with confidence.





## Where Do You Want to Go?

The path to success just got shorter. Swagelok high-purity and ultrahigh-purity offerings help ensure clean manufacturing. Not only do we have the products, but we provide customized solutions too. We consider your operating environment and account for factors such as corrosiveness, the need for repeatability and throughput, and eliminating contamination. Innovations like our ALD valve enhance manufacturing efficiency of semiconductor components. Swagelok's ongoing commitment to quality ensures speed, consistency, and cleanliness—every time.





## From Wafer to Die

When it comes to semiconductor manufacturing, you know best what you need. High yield and throughput. Maximum cleanliness and reliability. Swagelok helps you get there with our innovative products, manufactured to the highest standards of cleanliness and customizable for your application.

- Smooth internal surface finish reduces the risk of particle entrapment and material contamination
- Innovative designs promote fewer areas for entrapment, rapid purging, and less stress in high-cycle applications

We don't stop there, though. We back our products with support for your high- and ultrahigh-purity applications, from fabrication to finished product.





## Fittings

Choose the right fittings for your application.

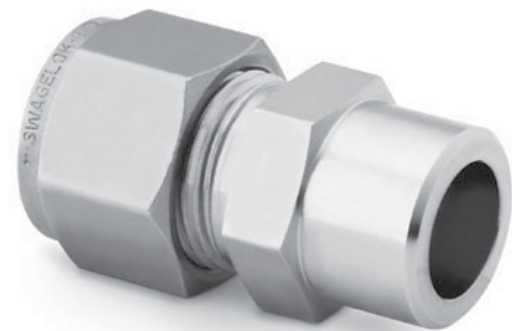




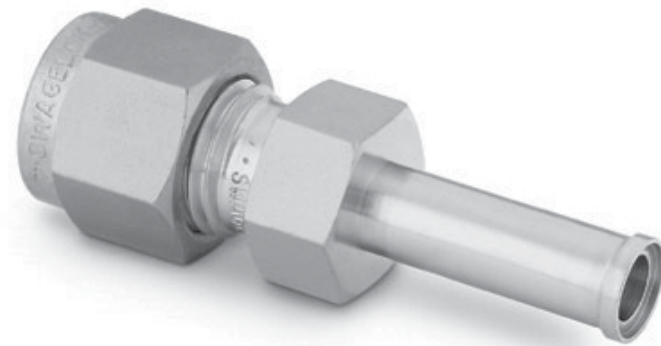
## Fittings

# Weld Fittings

Provide high-quality, permanent connections.



Tube Socket Weld [➤](#)




Automatic Tube Butt Weld [➤](#)



Butt Weld [➤](#)




Fittings  
Weld Fittings

Tube Socket Weld	How Does This Product Meet My Application Needs?
	<p>Especially suited for areas in which entrapment and potential corrosion are not a risk. Welded design may create entrapment areas, resulting in increased dry-down times and potential corrosion.</p> <p>Nonautogenous weld requires filler material. Care should be taken to ensure filler material is compatible with requirements of the manufacturing process.</p>



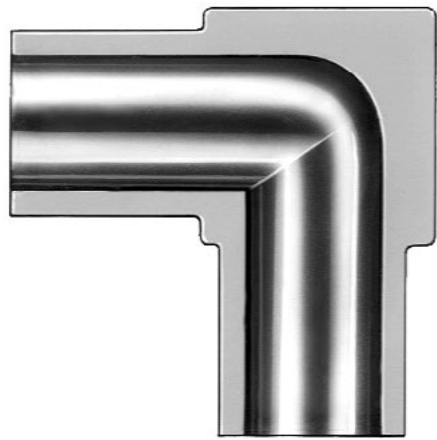


Fittings  
Weld Fittings

Automatic Tube Butt Weld	How Does This Product Meet My Application Needs?
	<p>Design facilitates reduced entrapment area.</p> <p>Autogenous weld; no filler material required.</p> <p>Alignment enhanced by integral filler ring.</p>



Fittings  
Weld Fittings

Butt Weld	How Does This Product Meet My Application Needs?
	<p>Constructed of materials especially suited for ultrahigh-purity applications.</p> <p>Autogenous weld; no filler material required.</p> <p>Especially for installation in small spaces where component spacing is minimal.</p> <p>Designed for enhanced alignment and precise fit; full tube penetration avoids entrapment, corrosion, and leakage.</p>

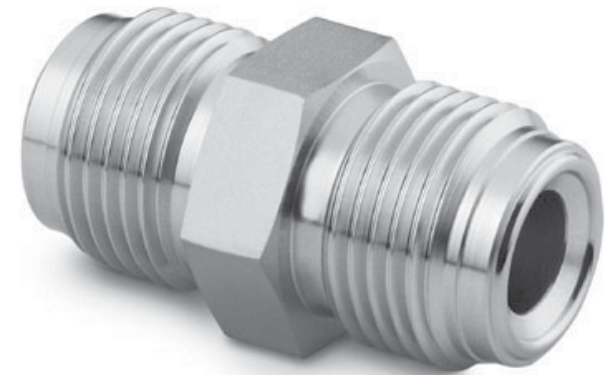




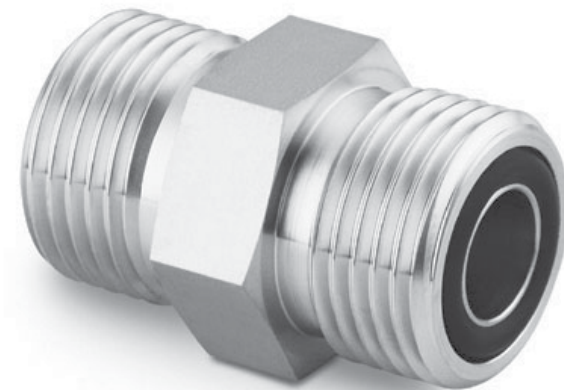
## Fittings

# Face Seal Fittings

Deliver leak-tight service from vacuum to positive pressure.



VCR Metal Face Seal [➤](#)

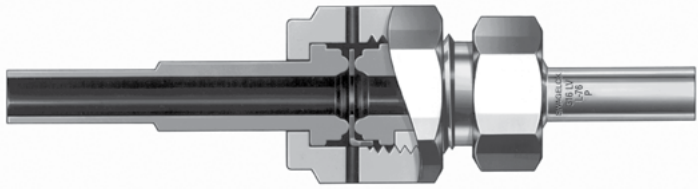


VCO O-Ring Face Seal [➤](#)



Fittings

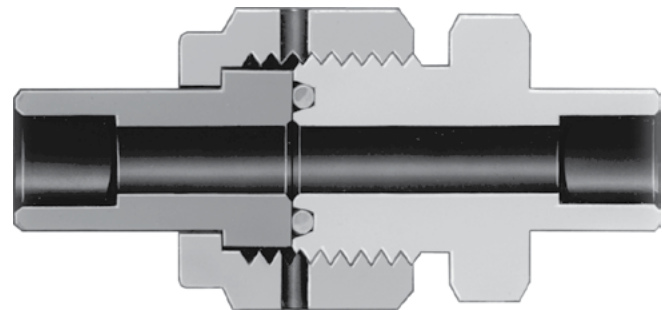
# Face Seal Fittings

VCR Metal Face Seal	How Does This Product Meet My Application Needs?
	<p>Metal-to-metal seal for ultrahigh-purity applications in a range of temperatures.</p> <p>Bead design and precision manufacturing provide optimal sealing mechanism.</p> <p>Ideal for easy, rapid installation where space is limited; no axial clearance required.</p> <p>Variety of <a href="#">gasket options</a> suited for specific requirements.</p> <p>See available <a href="#">options and accessories</a>.</p>



Fittings

# Face Seal Fittings

VCO O-Ring Face Seal	How Does This Product Meet My Application Needs?
	<p>Designed for high-purity applications in a range of temperatures.</p> <p>Smooth finish on gland face and vacuum coupling captive O-ring provide leak-tight sealing.</p> <p>Ideal for easy, rapid installation where space is limited; no axial clearance required.</p> <p>See available <a href="#">options and accessories</a>.</p>



## Fittings Options and Accessories

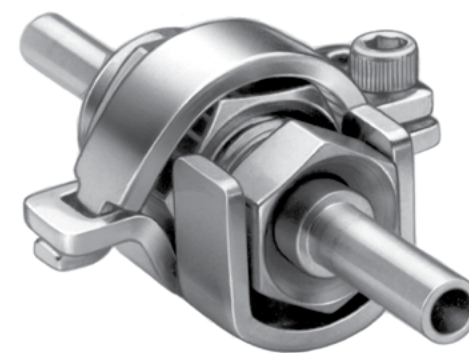
Deliver leak-tight service from vacuum to positive pressure.



Gaskets [➤](#)




Flow Restrictors [➤](#)



Locking Devices [➤](#)

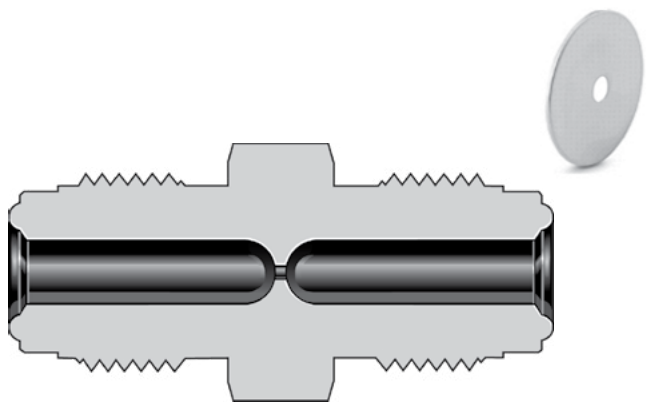


Fittings  
Options and Accessories

Gaskets	How Does This Product Meet My Application Needs?
	<p>Gaskets available in stainless steel, copper, and nickel; plated and electropolished.</p> <p><b>Blind:</b> Protects unused ends for cleanliness.</p> <p><b>Retained:</b> Provides additional security in gasket placement.</p> <p><b>Side-Load Retainer:</b> Facilitates installation in compact spaces.</p> <p><b>Snubber:</b> Provides filtration for added protection to internal components. Available in a variety of filtration levels.</p>



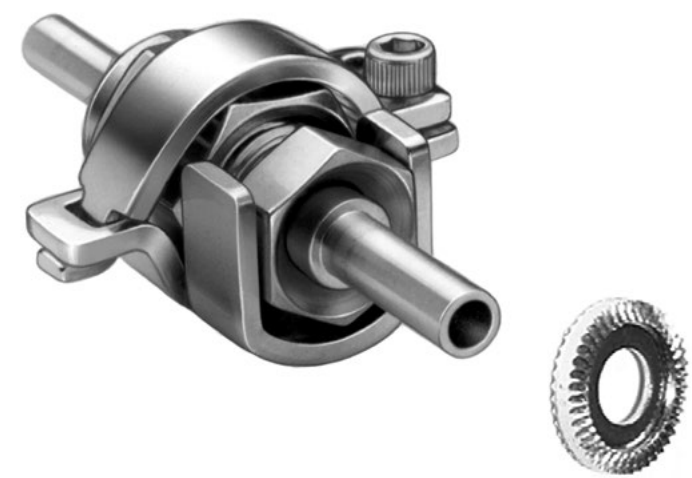
Fittings  
Options and Accessories

Flow Restrictors	How Does This Product Meet My Application Needs?
	<p>Used in liquid or gas delivery systems where repeatable flow reduction or limiting is required.</p> <p>Restricting orifices available in sizes to meet your flow requirements.</p>





Fittings  
Options and Accessories

Locking Devices	How Does This Product Meet My Application Needs?
	<p>Designed for high-torque, high-vibration applications. When used together, these devices increase vibration resistance for better fitting performance and longer life.</p> <p><b>Locking Device:</b> Clamps on the nuts to prevent unintentional disassembly of VCR fitting components.</p> <p><b>Knurled Gasket:</b> Prevents gland rotation.</p>

## Valves

Choose the right valves for your application.





## Valves

# ALD Valves

Ultrahigh-purity valves for atomic layer processing.

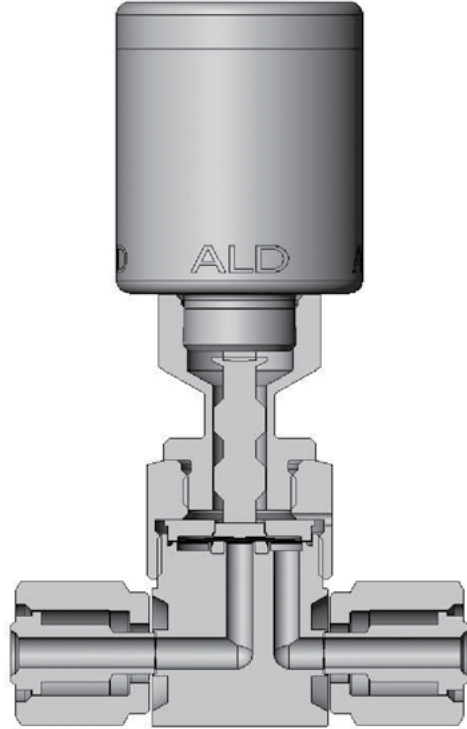


ALD3/6 Series Valves [➤](#)



ALD20 Series Valve [➤](#)


Valves  
ALD Valves

ALD3 and ALD6 Valves	How Does This Product Meet My Application Needs?
	<p>Diaphragm designed for ultrahigh life cycle.</p> <p>Pneumatic actuator for high-speed performance, repeatability, and flow consistency delivers precise chemical dosing.</p> <p>Optional thermal actuator limits conductive heat transfer from the body to the actuator.</p> <p>Learn more about the <a href="#">fixed soft seat</a> used with this valve.</p>





Valves  
ALD Valves

ALD20	How Does This Product Meet My Application Needs?
	<p>Ultrahigh-purity bellows designed for high flow and ultrahigh cycle life.</p> <p>Broad range of chemical compatibility; fully temperature immersible.</p> <p>Pneumatic actuator for high-speed performance, repeatability, and flow consistency delivers precise chemical dosing.</p> <p>Optional high-temperature optical position sensor.</p>



## Valves

# Bellows Valves

Perform reliably in high-purity applications.



Conventional Bellows Valve B Series ➤



Inverted Bellows Valve BN Series ➤

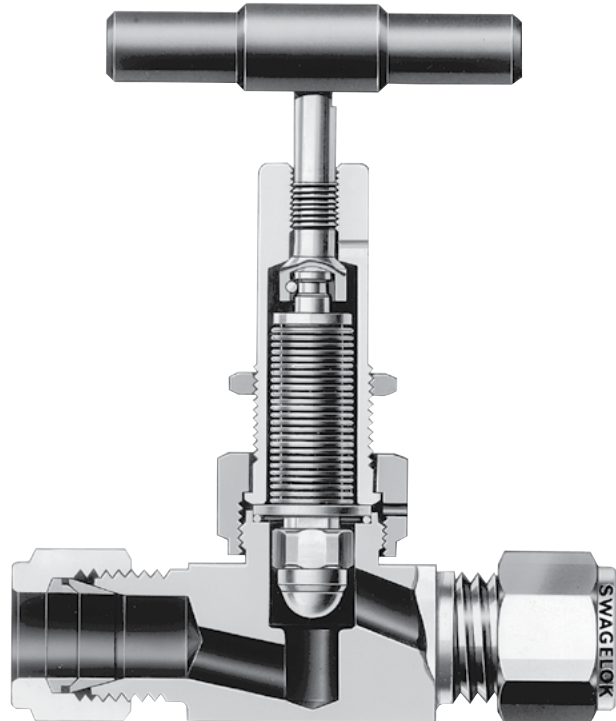


Bellows Metering Valve BM Series ➤



Valves

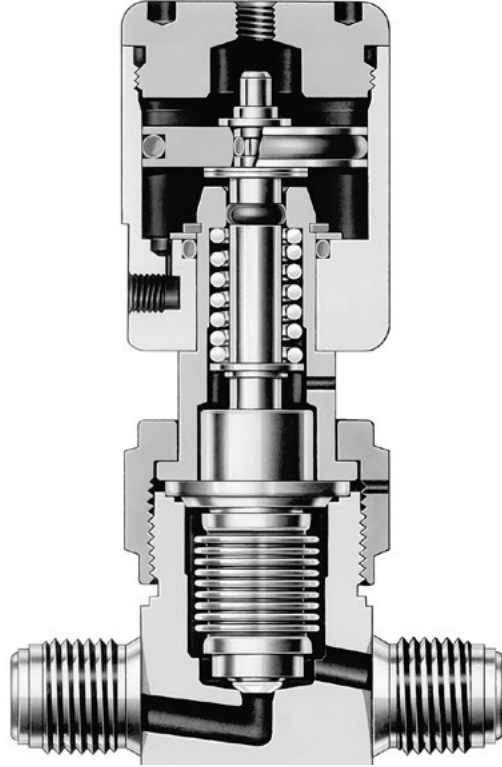
# Bellows Valves

Conventional Bellows Valve B Series	How Does This Product Meet My Application Needs?
	<p>All-metal bellows seal to atmosphere for leak-tight performance.</p> <p>Internally pressurized conventional bellows design for reliable operation.</p> <p>Nonrotating stem tip extends seat-sealing capability in high-cycle applications.</p> <p>Union bonnet design facilitates inspection and cleaning.</p> <p>Learn more about the <a href="#">all-metal seat</a> used with this valve.</p>



Valves

# Bellows Valves

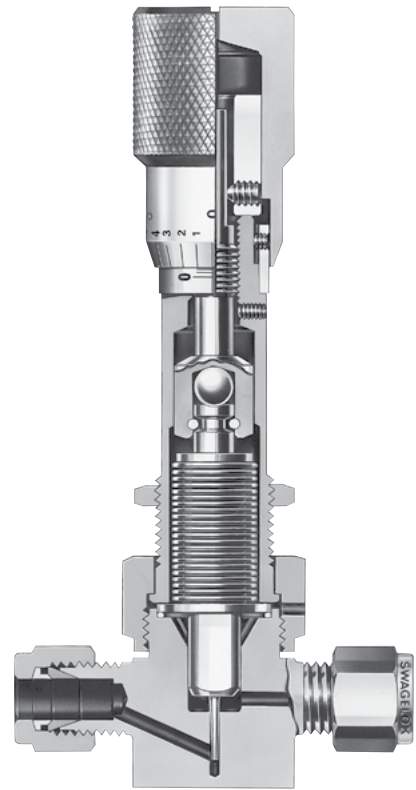
Inverted Bellows Valve BN Series	How Does This Product Meet My Application Needs?
	<p>Externally pressurized, inverted bellows for improved flow path.</p> <p>Swept flow path enhances purging and gas replacement for clean operation.</p>





Valves

# Bellows Valves

Bellows Metering Valve BM Series	How Does This Product Meet My Application Needs?
	<p>Bellows seal to atmosphere for reliable operation.</p> <p>Micrometer adjustment and tapered stem tip for fine flow control.</p> <p>Learn more about the <a href="#">metering stem tip seat</a> used with this valve.</p>



## Valves

# Diaphragm Valves

Clean, leak-proof operation reduces risk of escaping emissions.



ALD3/6 Series Valve ➤



Springless Diaphragm Valve DP/DPX Series ➤



High-Flow Springless Diaphragm Valve DF/DFX Series ➤



Thermal Immersion Diaphragm Valve DH Series ➤



Diaphragm Valve DL Series ➤

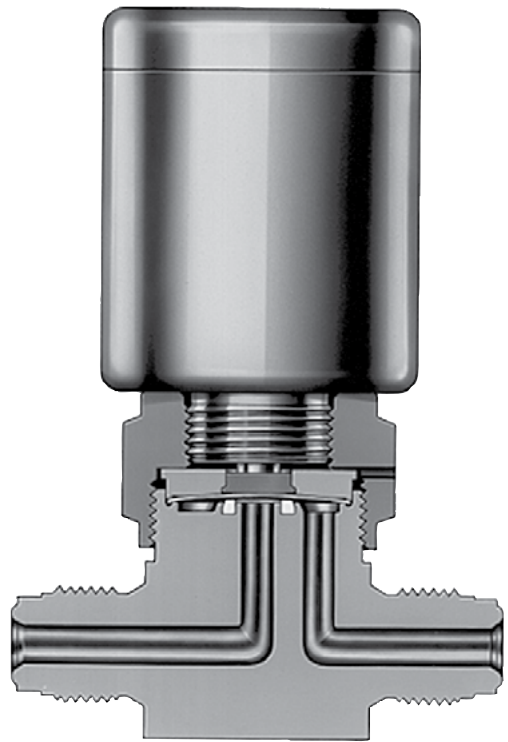


Plastic Radial Diaphragm Valve DRP Series ➤



Valves


# Diaphragm Valves

Springless Diaphragm Valve DP/DPX Series	How Does This Product Meet My Application Needs?
	<p>Springless diaphragm design eliminates need for internal spring or tied diaphragm, creating a fully swept flow path.</p> <p>Fully swept flow path enhances purging and gas replacement for ultraclean operation.</p> <p>Replaceable seat options available.</p> <p>Learn more about the <a href="#">fixed soft seat</a> used with this valve.</p>



Valves

# Diaphragm Valves


High-Flow Springless Diaphragm Valve DF/DFX Series	How Does This Product Meet My Application Needs?
	<p>High-flow springless diaphragm design eliminates need for internal spring or tied diaphragm, creating a fully swept flow path.</p> <p>Fully swept flow path enhances purging and gas replacement for ultraclean operation.</p> <p>Replaceable seat options available.</p> <p>Learn more about the <a href="#">fixed soft seat</a> used with this valve.</p>





Valves

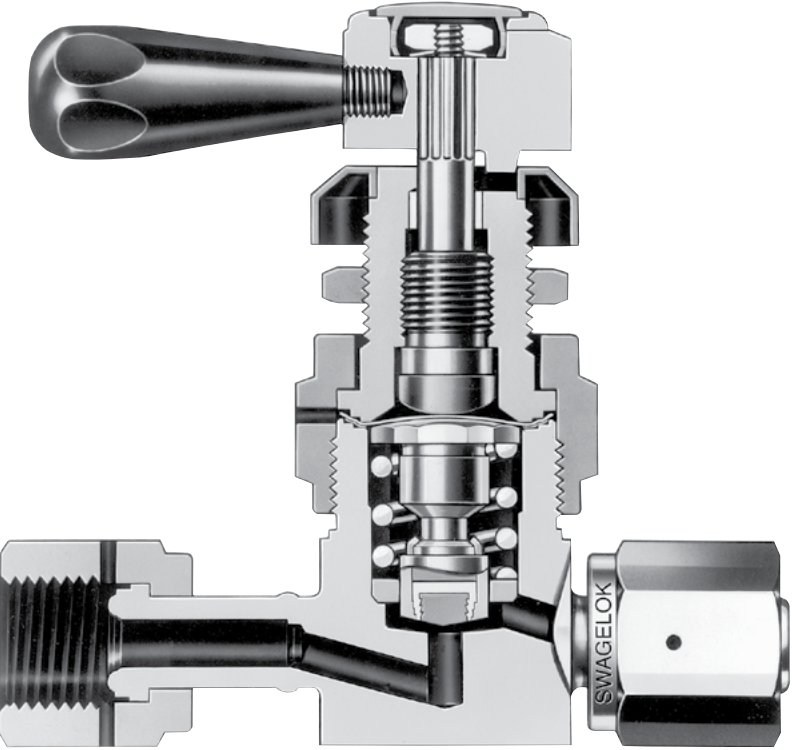
# Diaphragm Valves

Thermal Immersion Diaphragm Valve DH Series	How Does This Product Meet My Application Needs?
	<p>Diaphragm designed for ultrahigh life cycle.</p> <p>Pneumatic actuator for high-speed performance and repeatability.</p> <p>Suited for high-temperature applications; fully immersible at temperatures up to 220°C (428°F).</p> <p>Actuator seals designed for vacuum environments.</p> <p>Body and actuator replacement kits for ease of maintenance.</p> <p>Learn more about the <b>fixed soft seat</b> used with this valve.</p>



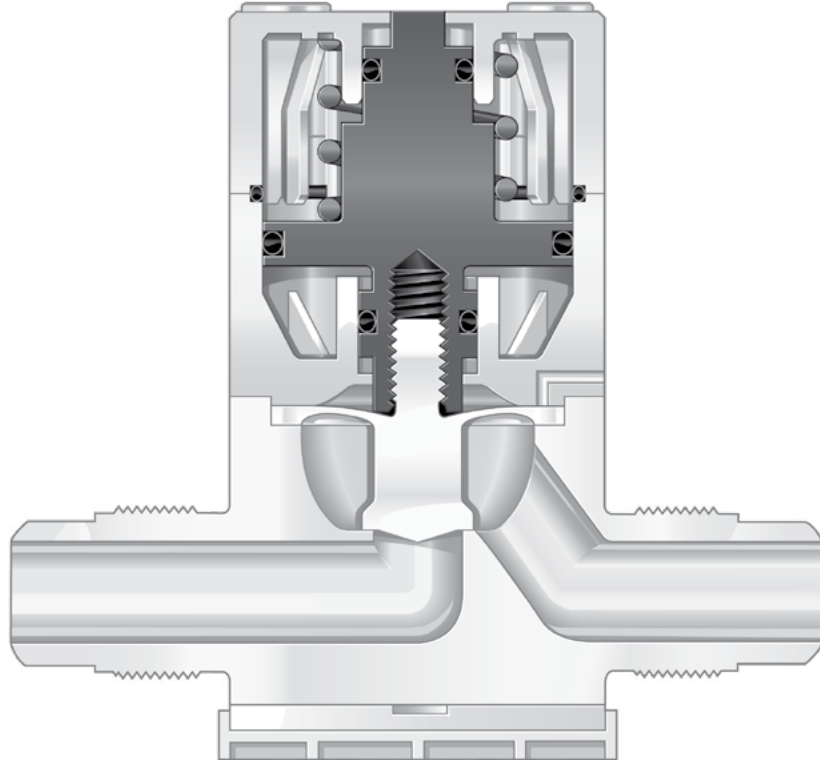
Valves

# Diaphragm Valves

Diaphragm Valve DL Series	How Does This Product Meet My Application Needs?
	<p>Spring-return stem tip is suitable for high-pressure applications.</p> <p>All-metal body seal for resistance to strong chemistries and reduced emissions.</p> <p>Learn more about the <a href="#">compensating soft seat</a> used with this valve.</p>

Valves

# Diaphragm Valves

Plastic Radial Diaphragm Valve DRP Series	How Does This Product Meet My Application Needs?
	<p>Tied diaphragm connects upper and lower stems to pull seat away from valve for higher flow and improved purging.</p> <p>Soft-acting spring closure helps prevent hydraulic shock, particle generation, and damage to the seat seal.</p>






Valves

# High-Purity Check Valves

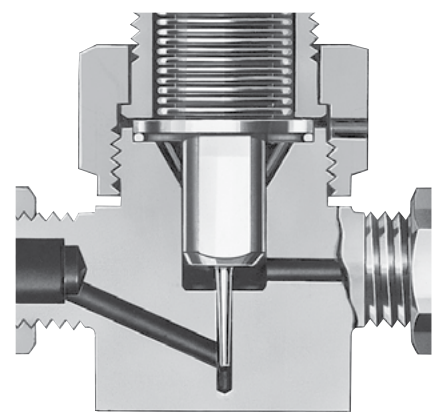
Clean, leak-proof operation reduces risk of escaping emissions.

Check Valve CW Series	How Does This Product Meet My Application Needs?
	<p>All-welded construction; no seal for resistance to strong chemistries and reduced emissions.</p> <p>Linear guidance wafer aligns poppet for less particle generation, resulting in less contamination.</p> <p>Bonded elastomer poppet eliminates wetted O-ring for longer life.</p>

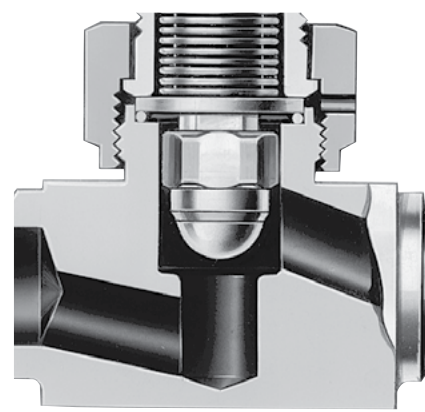


## Valves Valve Seats

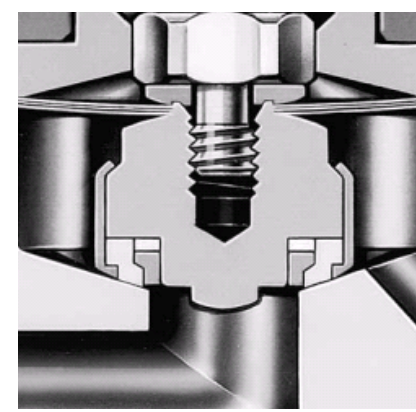
Provide precise flow control in a variety of valve designs.



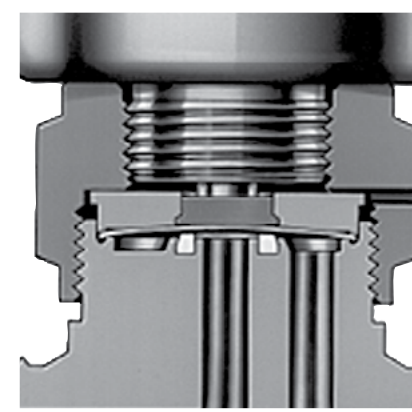
Metering Stem Tip Seat >



All-Metal Seat >

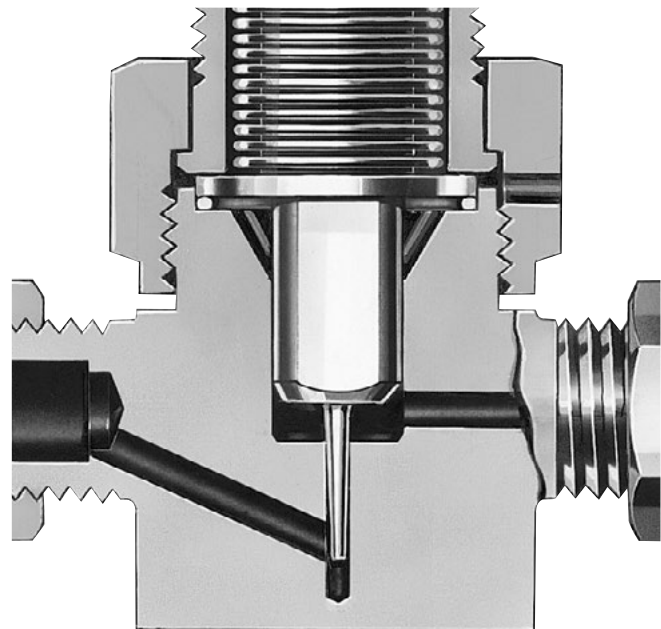


Compensating Soft Seat >



Fixed Soft Seat >

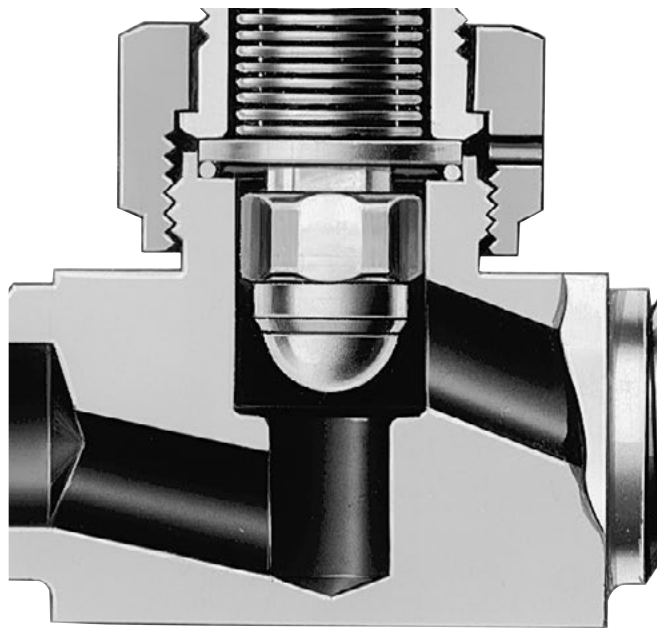
Valves  
Valve Seats

Metering Stem Tip Seat	How Does This Product Meet My Application Needs?
	<p>Suited for high-temperature applications.</p> <p>Metering stem tip provides fine flow control.</p> <p>Not for use in shutoff applications or applicable to diaphragm valve designs.</p>



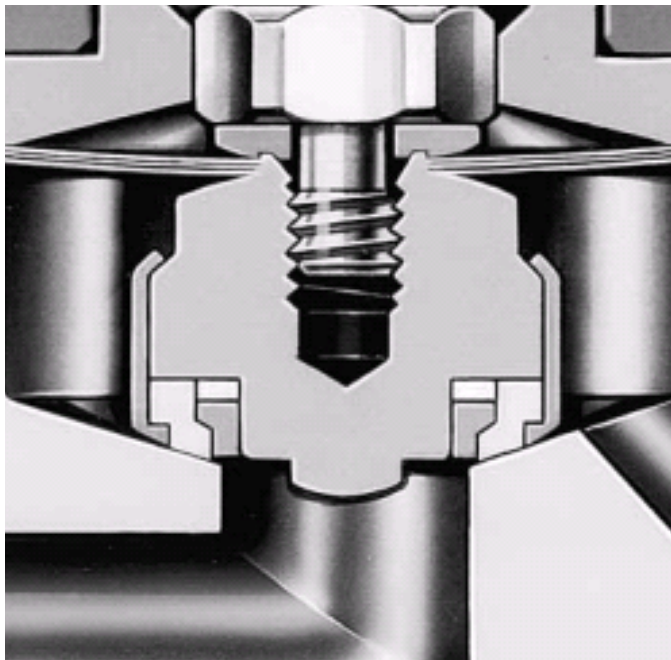


Valves  
Valve Seats

All-Metal Seat	How Does This Product Meet My Application Needs?
	<p>Suited for high-temperature and corrosive applications.</p> <p>Sensitive to contamination from potential particle generation from metal-on-metal surfaces.</p>

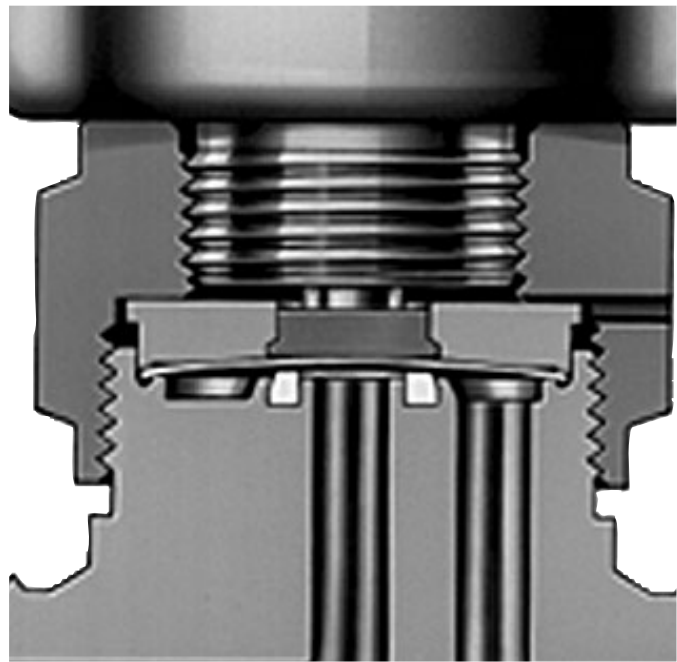


Valves  
Valve Seats

Compensating Soft Seat	How Does This Product Meet My Application Needs?
	<p>Suited for moderate-temperature applications.</p> <p>Positive, long-life shutoff.</p> <p>Compensating seat action ensures contamination resistance.</p> <p>Not adaptable to springless diaphragm valves.</p>



Valves  
Valve Seats

Fixed Soft Seat	How Does This Product Meet My Application Needs?
	<p>Low internal volume for ultrahigh-purity applications.</p> <p>Positive containment and fully contained high-purity grade wide seat for optimum shutoff.</p> <p>Excellent resistance to swelling and contamination.</p> <p>Sensitive to gross contamination.</p>





## Valves

# Special Valve Configurations

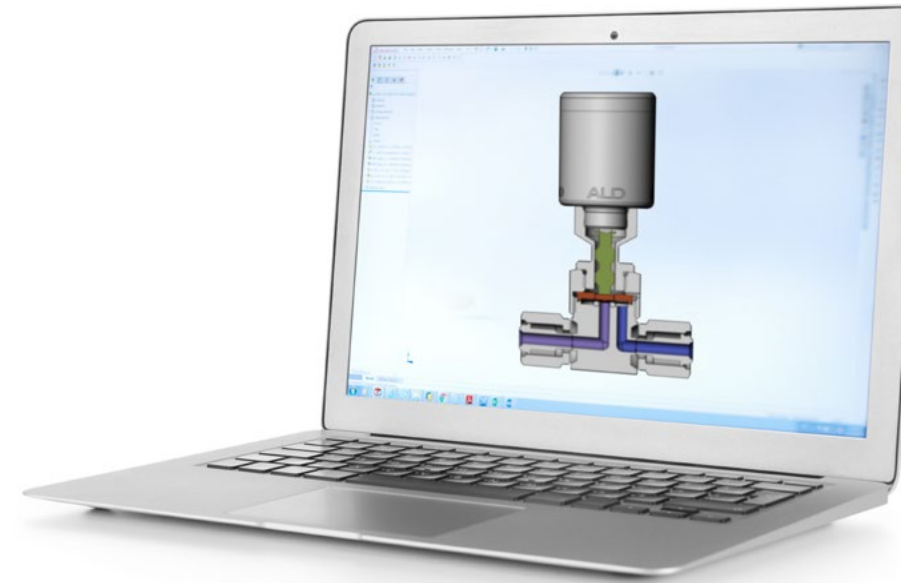
Maximize flow and minimize leak points with any valve.



Monoblock and Multi-Valve Manifold >




Multi-Port Valve >



Custom Valve Configurations >


Valves

# Special Valve Configurations

Monoblock and Multi-Valve Manifold	How Does This Product Meet My Application Needs?
	<p>Reduced number of connections decreases the number of potential leak points.</p> <p>Reduced internal system volume for faster purging.</p>

Valves

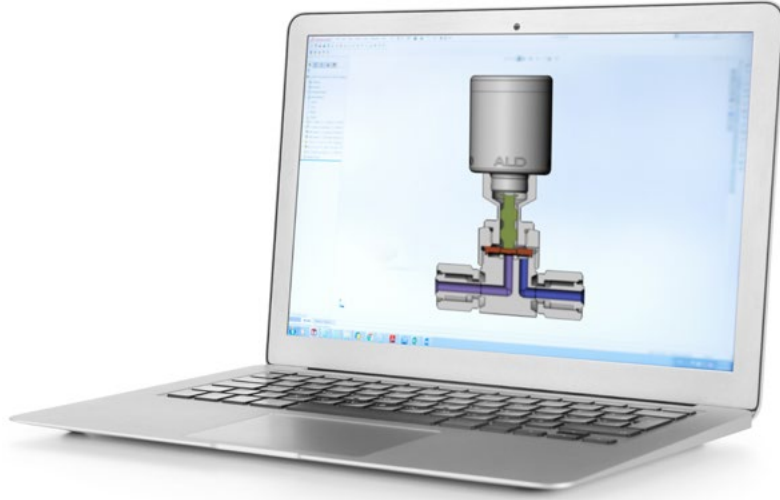
# Special Valve Configurations

Multi-Port Valve	How Does This Product Meet My Application Needs?
	<p>Several port options provide multiple flow paths for flexibility.</p> <p>Reduced internal system volume for faster purging.</p>



Valves

# Special Valve Configurations

Custom Valve Configurations	How Does This Product Meet My Application Needs?
	<p>We understand that your system may require fluid system components that are designed to meet specific operational parameters. Swagelok engineers can design and manufacture custom-made parts that are tailor-made for your system. These uniquely designed components ensure that your system is functioning precisely as you expect while guaranteeing maximum efficiency and functionality.</p>



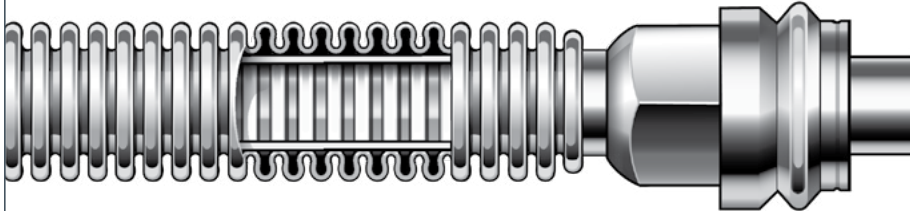
## Hoses and Tubing

Choose the right hose and tubing for your application.



Hoses  
PTFE-Metal Hybrid

Engineered for low-pressure UHP applications.


FP Series	How Does This Product Meet My Application Needs?
	<p>Engineered for low-pressure UHP applications where permeation to the atmosphere is undesirable.</p> <p><b>Features:</b> 316L outer cover, smooth bore PTFE core, welded 316L end connections</p>





Hoses  
Metal

Provides flexibility and strength.

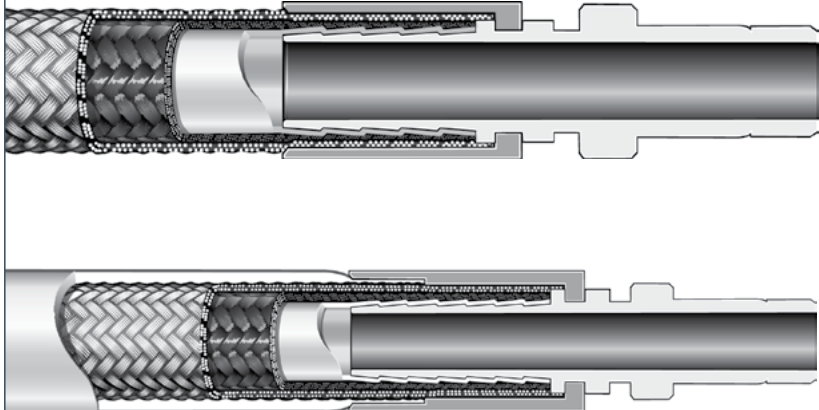
FJ and FL Series	How Does This Product Meet My Application Needs?
	<p>Provides flexibility and strength in high-temperature vacuum or general-purpose applications where permeation is undesirable.</p> <p><b>Features:</b> 304 SS braid, 316L SS core, 316L end connections</p>





Hoses  
PTFE

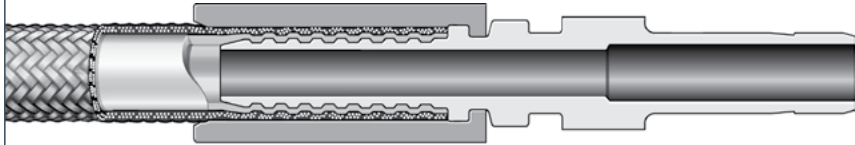
Highly flexible with PTFE core.

X and S Series	How Does This Product Meet My Application Needs?
	<p>Designed to combine high flexibility and chemical compatibility. Silicone cover options are available.</p> <p><b>Features:</b> 304 SS braid, smooth-bore PTFE core, 316L end connections</p>



Hoses  
PTFE

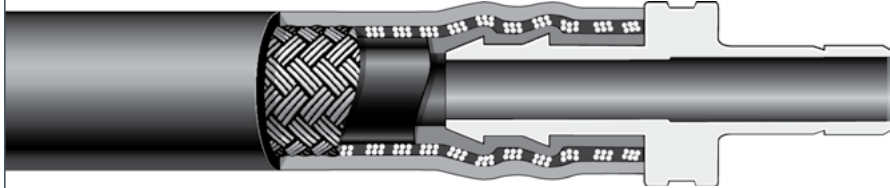
Highly flexible with PTFE core.

T Series	How Does This Product Meet My Application Needs?
	<p>For applications where chemical compatibility and permeation resistance are desired.</p> <p><b>Features:</b> 304 SS braid, PTFE core, SS collar, 316 SS end connections</p>



Hoses  
Rubber

For general purpose applications.

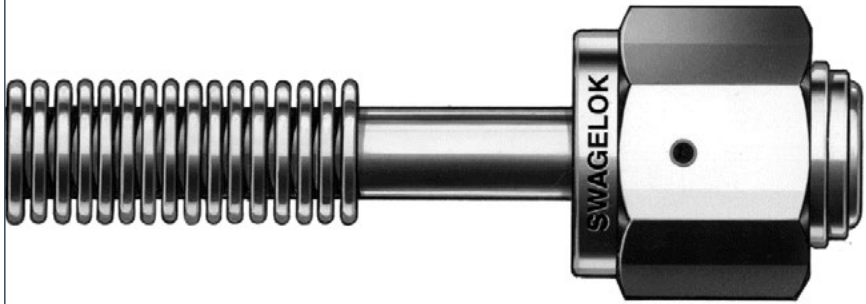
PB Series	How Does This Product Meet My Application Needs?
	<p>Designed for use in general-purpose applications.</p> <p><b>Features:</b> Buna N cover and core, synthetic reinforcement, 316 SS and brass end connections</p>



Tubing

# Convolute Metal

For high temperature or low pressure.

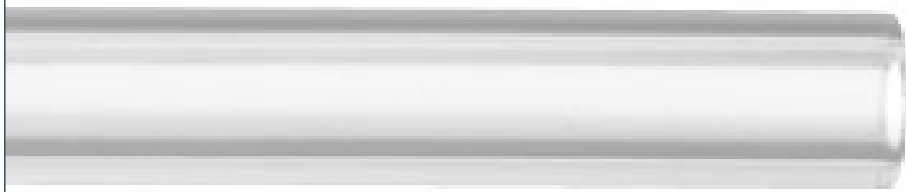
Convolute Metal Tubing	How Does This Product Meet My Application Needs?
	<p>For use in high-temperature vacuum or low-pressure static applications.</p> <p><b>Features:</b> 321 SS core and cuff, 316 SS end connections, 316 SS or 304 SS adapters</p>





Tubing  
PFA

Provides broad chemical compatibility.

PFA Series	How Does This Product Meet My Application Needs?
	<p>Flexible tubing for applications where chemical compatibility is desired.</p> <p><b>Features:</b> Smooth-bore PFA material, chemically resistant, translucent</p>



## Regulators

Provide chemical compatibility.



Pressure Regulator KPR Series

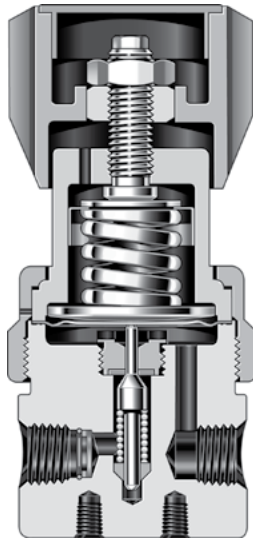


Compact High-Flow Gas Regulator HF Series



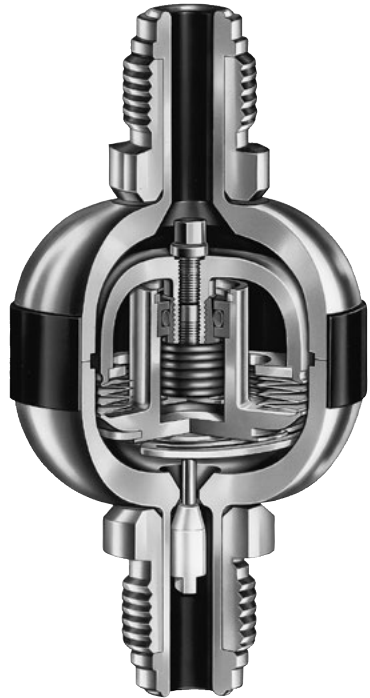
High-Flow Manual Gas Regulator HF Series

Regulators

Pressure Regulator KPR Series	How Does This Product Meet My Application Needs?
	<p>Metal-to-metal diaphragm seal for integrity against leaks.</p> <p>Free poppet operation, especially suited for inert gases and point-of-use process gases.</p> <p>Two-piece cap design provides linear load on the diaphragm seal.</p> <p>High-flow filter reduces contamination on the seat.</p>




Regulators

Compact High-Flow Gas Regulator HF Series	How Does This Product Meet My Application Needs?
	<p>Innovative gas-actuated pressure-sensing assembly results in low droop, which eliminates the need for adjustment in many systems.</p> <p>Self-centering, tied poppet for clean operation and positive shutoff; minimizes creep.</p> <p>All-welded design—no seals to atmosphere.</p> <p>Compact, high-flow design allows close spacing of system components and process lines.</p>





Regulators

High-Flow Manual Gas Regulator HFE Series	How Does This Product Meet My Application Needs?
	<p>Welded diaphragm assembly maximizes pressure-sensing area.</p> <p>Spring-loaded design allows manual adjustment of outlet pressure.</p> <p>Less than half the size of conventional.</p>



## From Idea to Installation

How do you make a great product even better? When you customize it to meet your exact requirements.

### Swagelok Engineered-to-Order Products

We know our products, and we know what they can do for you. Swagelok design experts help you customize our products to meet the demands of your application, then we build it, test it, ship it, and warranty it.

### Swagelok® Custom Solutions

We go beyond components to provide a complete, customized solution that brings together your idea and our expertise. And like our products, our solutions are backed by our limited lifetime warranty too.

### Support and Service

We support you with ongoing technical assistance and field engineering services to ensure your processes are operating exactly as you need them, when you need them to. Swagelok® fluid systems evaluation and advisory services bring the technical expertise, application experience, and industry knowledge of Swagelok field engineers to your facilities, helping you get the most from your fluid systems. Rely on these certified, locally available specialists to help you improve operational performance, reduce cost and labor time, and help mitigate safety, quality, and environmental risks.

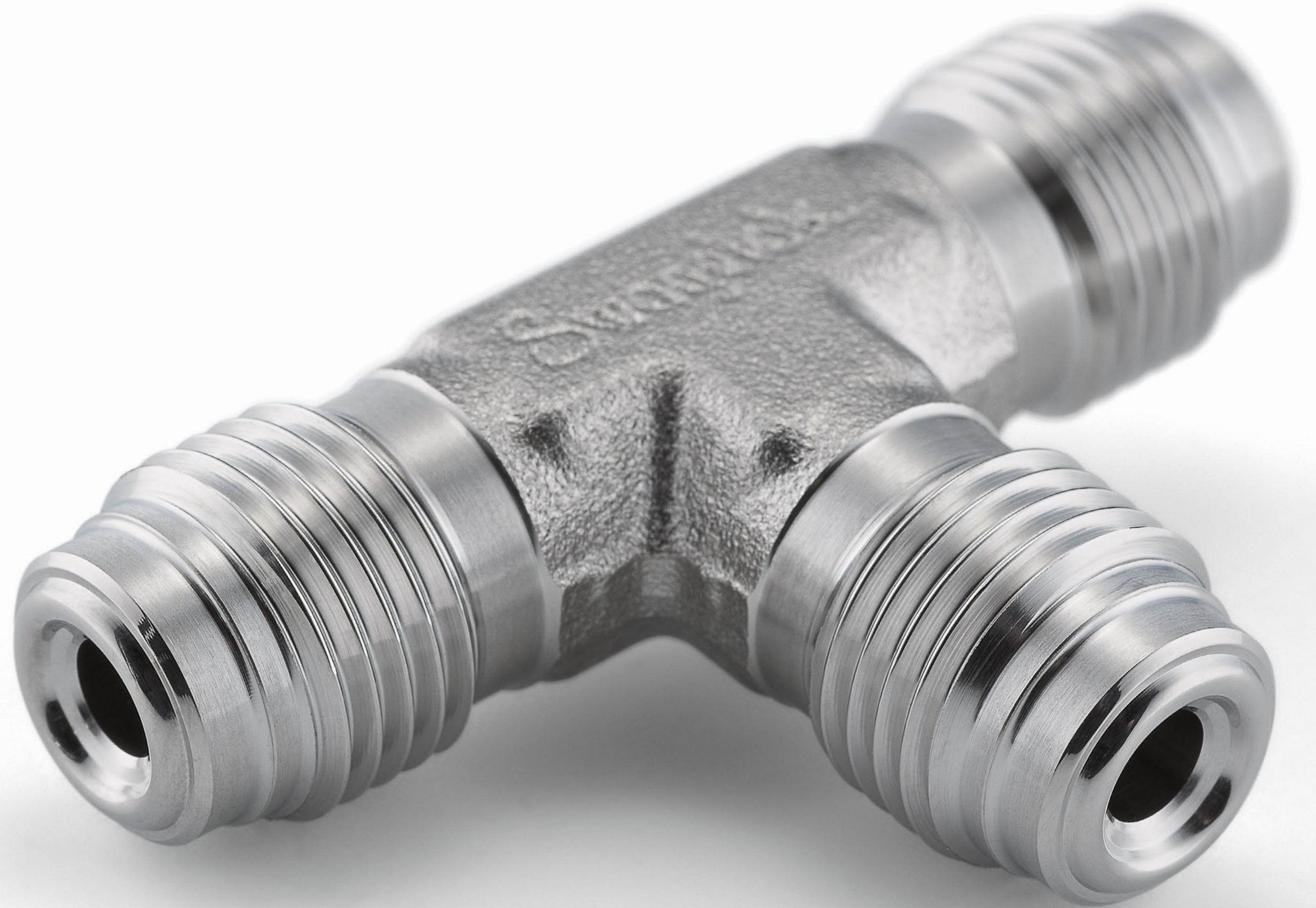
Start the conversation. Contact your [authorized sales and service center](#) today.





## Purity

Swagelok's ultrahigh-purity solutions provide clean, reliable changeover and greater thermal control; help prevent contamination; and promote safe containment.







## Choose Your Path With Material Options

Swagelok materials of construction are backed by science. They're formulated, tested, and proven for high-purity applications like semiconductor manufacturing. From the bar stock to the fluoropolymers, the properties of each of these materials help you to achieve the results you need. Swagelok chooses materials carefully for the manufacturing process, so you can be assured of materials that allow easy welding and installation, while providing you with the purity your application requires.

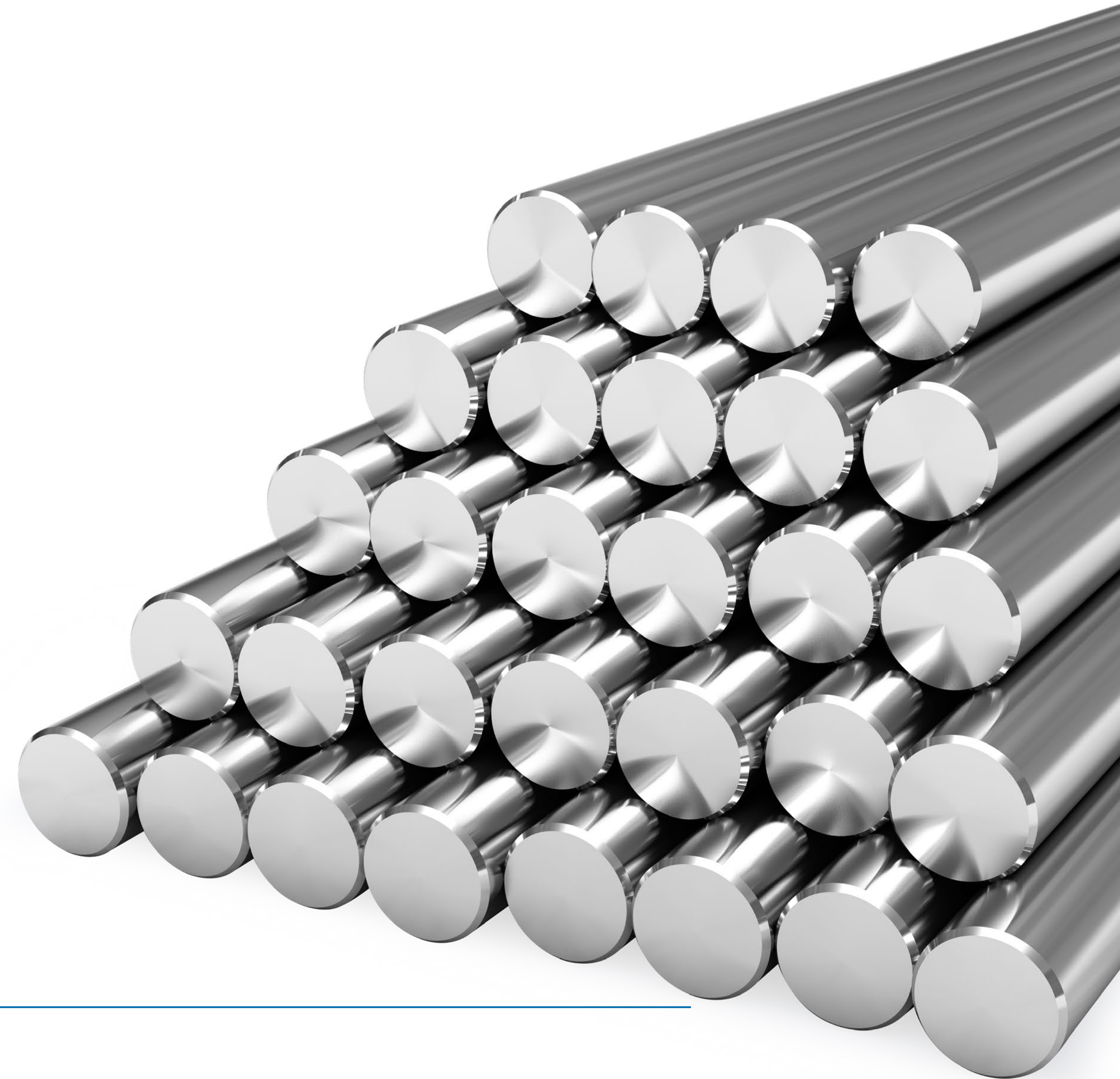




## Material Options

### 316/316L Stainless Steel

Swagelok's stainless steels are of the finest alloys, blended to offer the maximum corrosion resistance, strength, and ductility. Swagelok meets and, in most cases, exceeds standards, resulting in the right balance of material properties to ensure fitness for semiconductor applications.





## Material Options

# 6LV and 6LVV Stainless Steel

Swagelok offers multiple grades of 316 stainless steel for semiconductor manufacturing. Two of the most common types, both double-melted but differentiated by their primary melting methods, are:

- High-purity 6LV (AOD + VAR)
- Ultrahigh-purity 6LVV (VIM + VAR)



## Material Options

### Alloy 22

Other options for compatible special alloys include Alloy 22, a nickel-based alloy composed of chromium, molybdenum, and tungsten. With an iron content lower than other materials, Alloy 22 offers outstanding resistance to pitting and crevice corrosion, as well as to stress corrosion cracking, while maintaining weldability and performance in environments where corrosive chemistries are used.

#### Properties of Alloy 22

Alloy 22 offers optimum corrosion resistance in applications where moisture may be present. Because of its lower iron content, Alloy 22 is less likely to oxidize, so your process stays cleaner.

Alloy 22 is especially suited for more aggressive chemistries that are a characteristic of the evolving semiconductor manufacturing environment.







## Material Options Further Refining the Process

How can you make already pure materials even more pristine? Vacuum melting facilitates the removal of impurities. High-purity 6LV material is remelted in a vacuum with the VAR method (AOD+VAR). Ultrahigh-purity 6LVV material is twice vacuum-melted (VIM+VAR) for even greater cleanliness.





## Material Options SS compared to ASTM

For corrosion resistance, weldability, and material surface characteristics of the steel after it is polished or welded, you have to start with a better mix of alloys. Much of the stainless steel offered in the open market is made with lesser quantities of expensive elements, including nickel (Ni) and chromium (Cr). Swagelok optimizes the blend of alloys to formulate a melt for greater corrosion resistance and strength, as well as improved ductility.






Material Options


# 316/316L Stainless Steel Material Composition Compared to ASTM® Specifications


Specification Composition by Percentage

Cr  Chromium content is at the high end of the range specified by ASTM to help ensure corrosion resistance.

Ni  Nickel content is at the high end of the range specified by ASTM to maximize corrosion resistance.

S  Sulfur content is tighter than the range specified by ASTM to provide consistent weldability and machinability, without sacrificing the purity of the steel.

 ASTM Specification

 Swagelok 316L Specification



# Material Options

## Melting Processes

The Argon Oxygen Decarburization (AOD) refining process results in material with desired chemistry and integrity for clean manufacturing. The Vacuum Induction Melting (VIM) process produces ingots that can be used as electrodes in the remelting process to further refine the material. The Vacuum Arc Remelting (VAR) process is a second melting method used to further refine and purify materials produced by AOD or VIM.

Primary Process	Secondary Process	Purpose	Grade
AOD		Reduces the carbon content and recovers the steel's alloys. Impurities in the steel react with steel byproducts, such as slag, to refine the steel.	316/316L
AOD	VAR	In a VAR furnace, an electric arc remelts electrodes produced by the AOD process. Controlled melting and solidification in a vacuum leads to consistent chemistry and microstructure for resistance to fracture and fatigue.	6LV
VIM	VAR	The VIM+VAR process produces ingots with fewer impurities within an oxygen-free atmosphere. This limits the formation of nonmetallic oxide inclusions.	6LVV





## Material Options Weldability

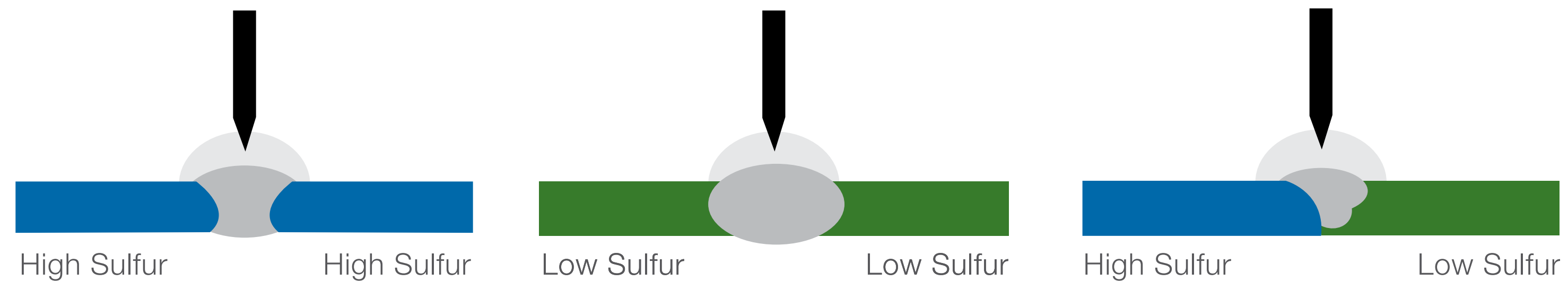
For added corrosion resistance, Swagelok's 316L stainless steel contains chromium and nickel content that is on the high end of the ASTM industry standard. But how do you best combine that added protection and still ensure the quality and integrity of the weld? The answer lies not just in the skill of the welder, but also in the material chemistry—specifically, in achieving just the right balance of chromium, nickel, and sulfur. Although the ASTM specification allows a wide range of sulfur content, this variability can make getting a consistent weld bead difficult and can impact throughput.



## Material Options

# The Importance of a Good Weld Profile

Sulfur content is closely related to weldability. Welding parts that are made from stock at the lower end of the sulfur content band to parts at the higher end of the band will not result in a consistent semiconductor-grade weld. When you're welding tubing and a fitting together, the differing sulfur content between the two surfaces can result in differing amounts of weld bead shift. A good weld bead profile, neither concave nor convex, with full penetration to the ID of the weld joint is an essential requirement for integrity in high-purity applications.





## Material Options Corrosion Resistance

Swagelok has pioneered with Semiconductor Equipment and Materials International (SEMI) the use of a Critical Pitting Temperature (CPT) test for determining corrosion resistance. SEMI has adopted the ASTM® G150 Standard Test Method for Electrochemical Critical Pitting Temperature Testing of Stainless Steels in the SEMI F77 standard, as an alternative to traditional surface analysis. CPT testing used in tandem with elemental analysis can relate differences in the surface layer with a material's pitting resistance. As well, they can be used as part of process control.





# Material Options

## Fluoropolymers

In the semiconductor industry, fluoropolymers are used to line the inside diameter (ID) of hoses that come in contact with fluids or gases, as well as soft components, such as valve seats and seals. Fluoropolymers offer stability at high temperatures used in semiconductor manufacturing and chemical and corrosion resistance, helping to ensure the purity of your processes.

Materials	Processing	Properties
Polytetrafluoroethylene (PTFE)	PTFE and modified PTFE are compression-molded. Because this process is cleaner than traditional plastic molding processes, the inner surfaces of the material remain free of metal residue.	PTFE is highly nonreactive, so it is especially suitable for reactive and corrosive chemicals commonly used in semiconductor manufacturing.
Modified Polytetrafluoroethylene (PTFE)		Modified PTFE is a chemically modified version that provides improved tensile strength and greater resistance to permeation.
Perfluoroalkoxy Alkane (PFA)	PFA is formed with a traditional injection molding and extrusion process. PFA combines the processing ease of conventional thermoplastic resins with the properties of PTFE.	In addition to properties found in PTFE, PFA also provides improved flow, creep resistance, and thermal stability.

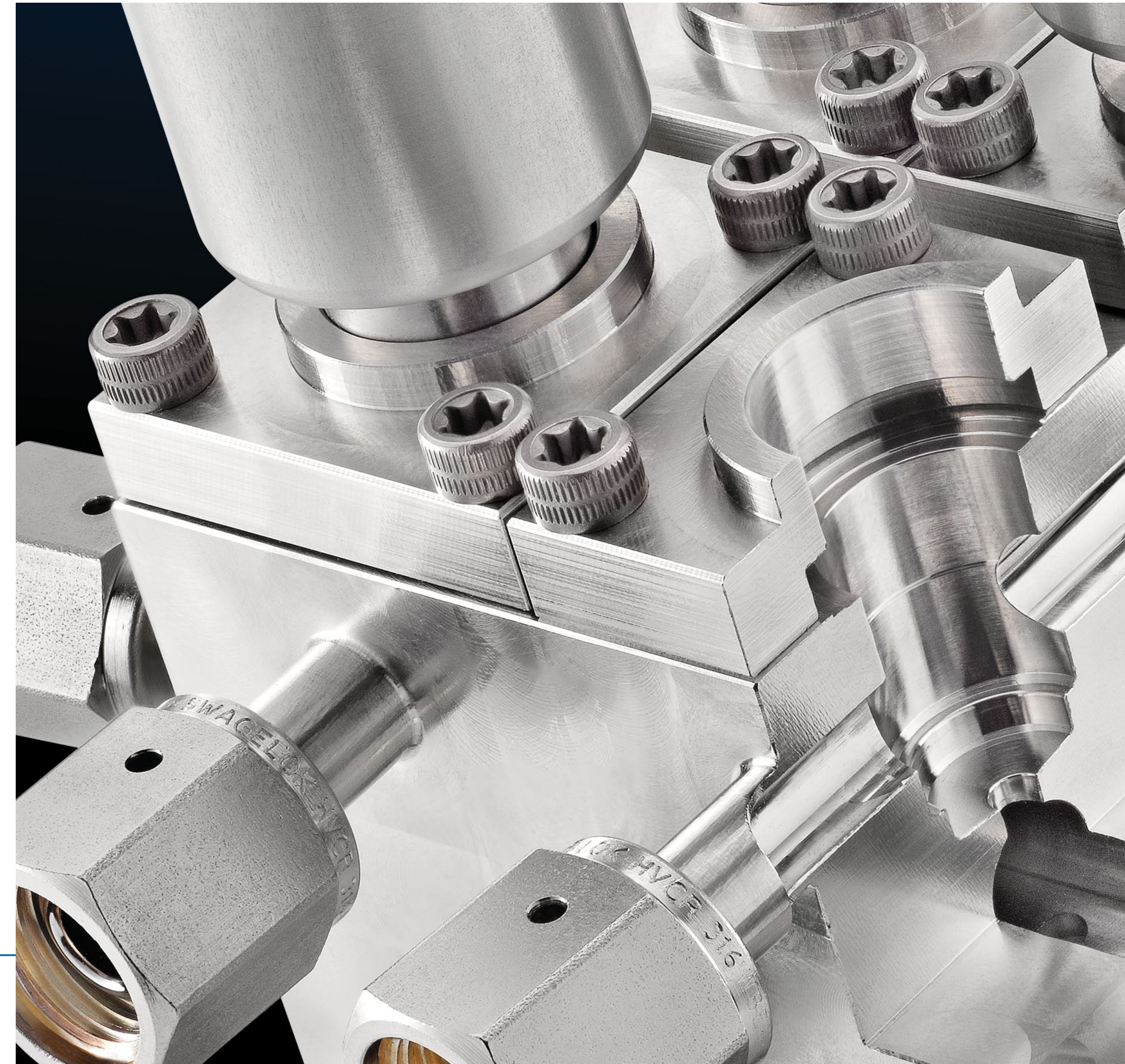




## Our Commitment to Manufacturing

Swagelok components are manufactured to ensure consistent quality, ultrahigh purity, corrosion resistance, and weldability. What begins with material selection is carried out in our stringent and highly controlled manufacturing processes, which include surface processing to help enhance corrosion resistance and minimize contamination by removing surface imperfections.

Swagelok materials are electropolished and finished with passivation.





## Manufacturing Electropolishing

Electropolishing is essential for creating a smooth inner surface for tubing to be used in gas distribution systems. Electropolishing is an electrochemical process that strips away metallic impurities and smooths imperfections, leaving a much cleaner surface. This process is superior for semiconductor applications as the potential for embedded abrasives left in the surface does not exist as with mechanical polishing.

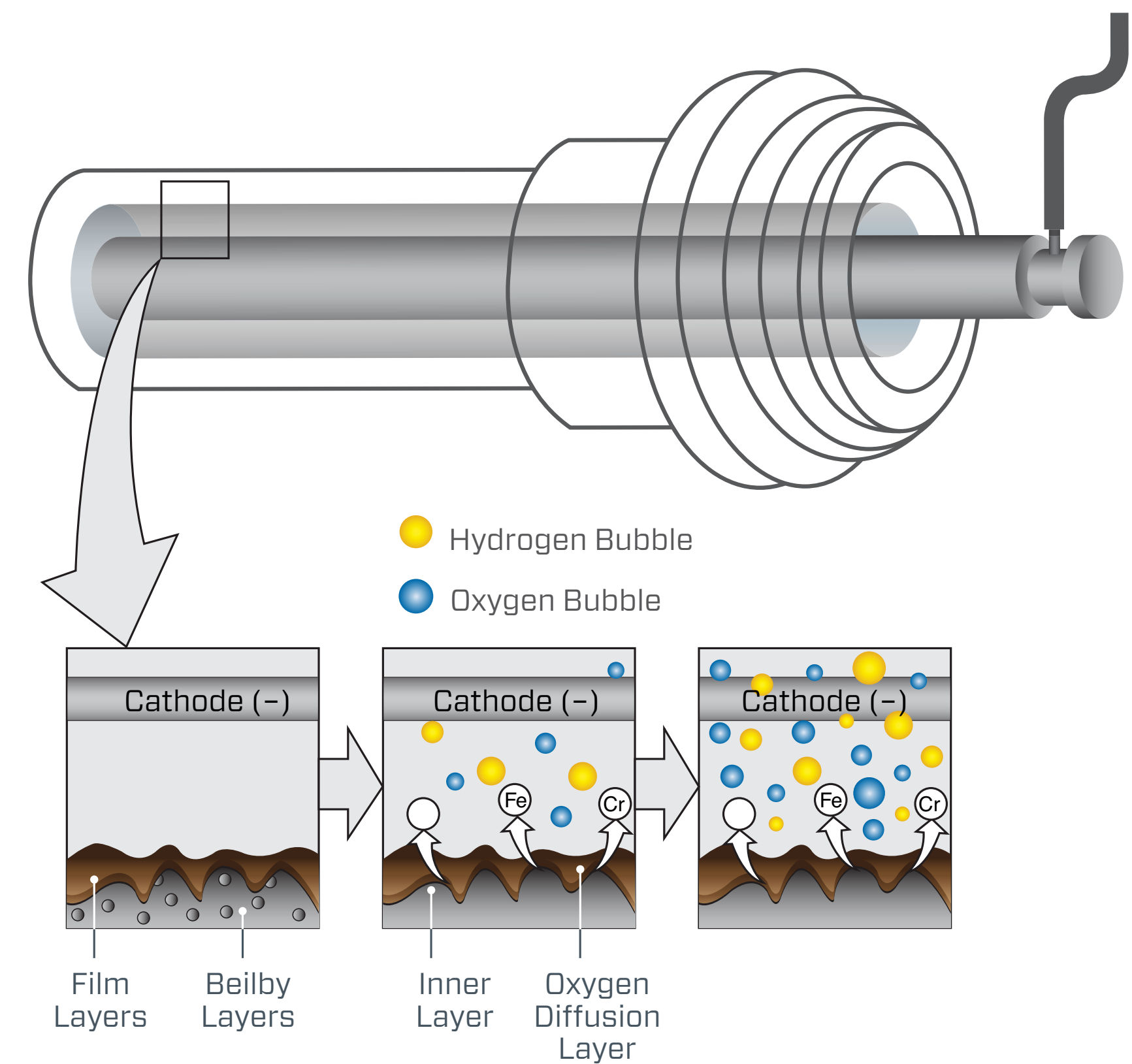




## Manufacturing How Electropolishing Provides a Clean Surface

During electropolishing, a viscous film forms on the anode, and the base metal surface dissolves through the film. Corrosion resistance is improved as a result of an enhanced chrome-to-iron ratio on the treated surface. This process results in a smoother surface and less area on a microscopic basis, which improves dry-down and system purge times.

Swagelok's tooling is designed to make sure the proper amount of current is applied as uniformly as possible to ensure optimal electropolishing.



## Manufacturing Passivation

Passivation further cleans the surface and promotes the material's corrosion resistance by creating a chromium-rich passive oxide layer.





## Our Commitment to Cleaning and Packaging

We stand behind our product offerings with our commitment to ultrahigh-purity manufacturing. We understand the UHP industry's unique requirements for cleanliness, so we can help you meet or exceed industry standards.





## Cleaning and Packaging Process Specifications

Various contaminants, such as machining oils/coolants, finishing media, and electropolishing electrolytes, can compromise purity if not thoroughly cleaned. Swagelok is the author of process specifications that encompass industry-leading requirements for performance and cleaning of components used in UHP manufacturing:

### [SC-01 Ultrahigh-Purity Process Specification](#) ⓘ

specifies guidelines for surface finish and materials of construction to help our products resist impurities and corrosion, resulting in less likelihood of contamination in semiconductor manufacturing.

### [SC-06 Photovoltaic Process Specification](#) ⓘ

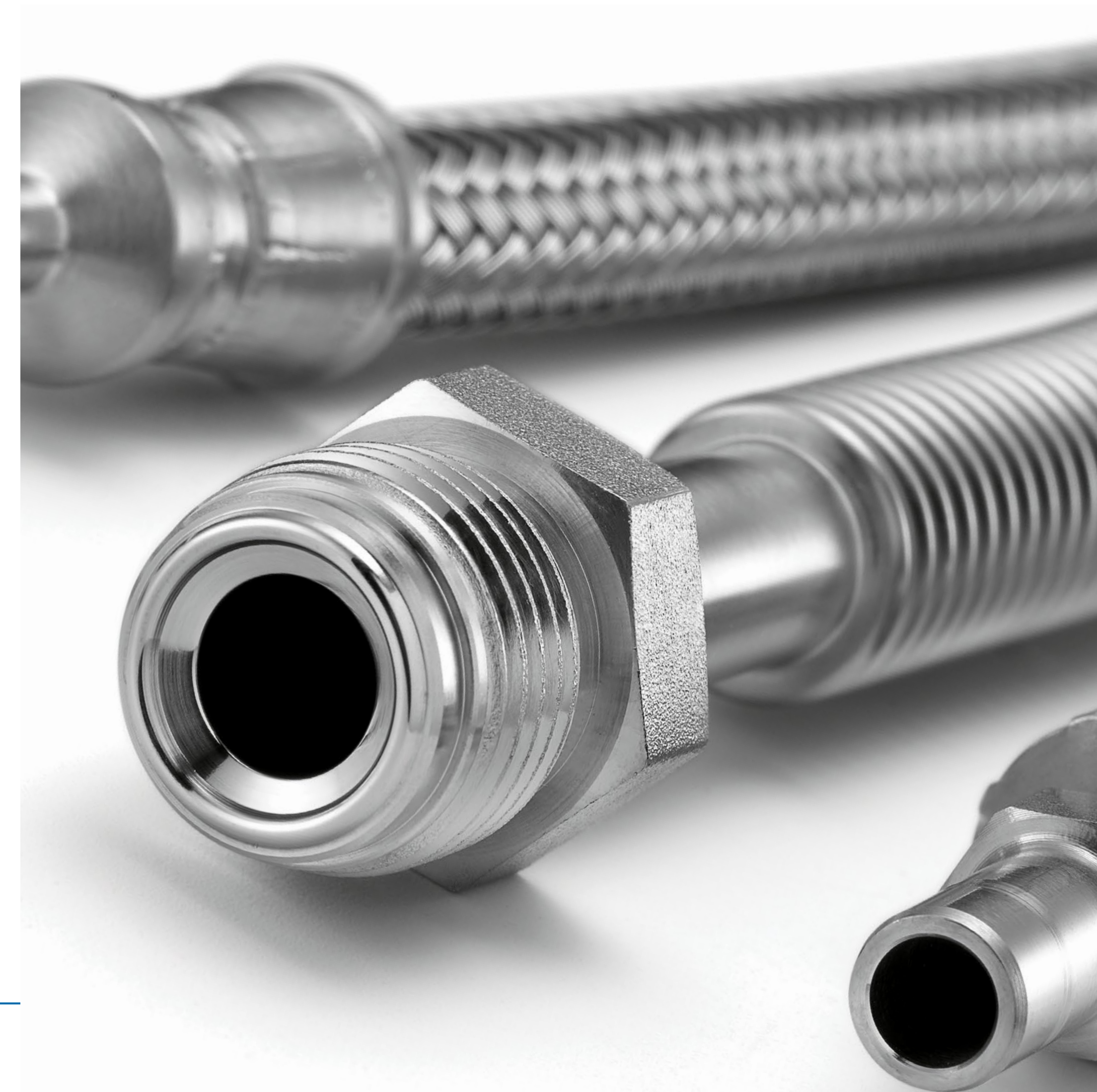
offers both electropolished and standard finish components in specific products for ultrahigh-purity applications.

### [SC-10 Standard Cleaning and Packaging Specification](#) ⓘ

defines the cleaning, lubrication, assembly, and packaging requirements for standard products and describes the practices used to meet these requirements.

### [SC-11 Special Cleaning and Packaging Specification](#) ⓘ

specifies cleaning and packaging requirements for wetted system components that exceed standard cleaning and packaging requirements. This specification helps to ensure that no lubricants enter the wetted stream or other critical paths in semiconductor manufacturing.

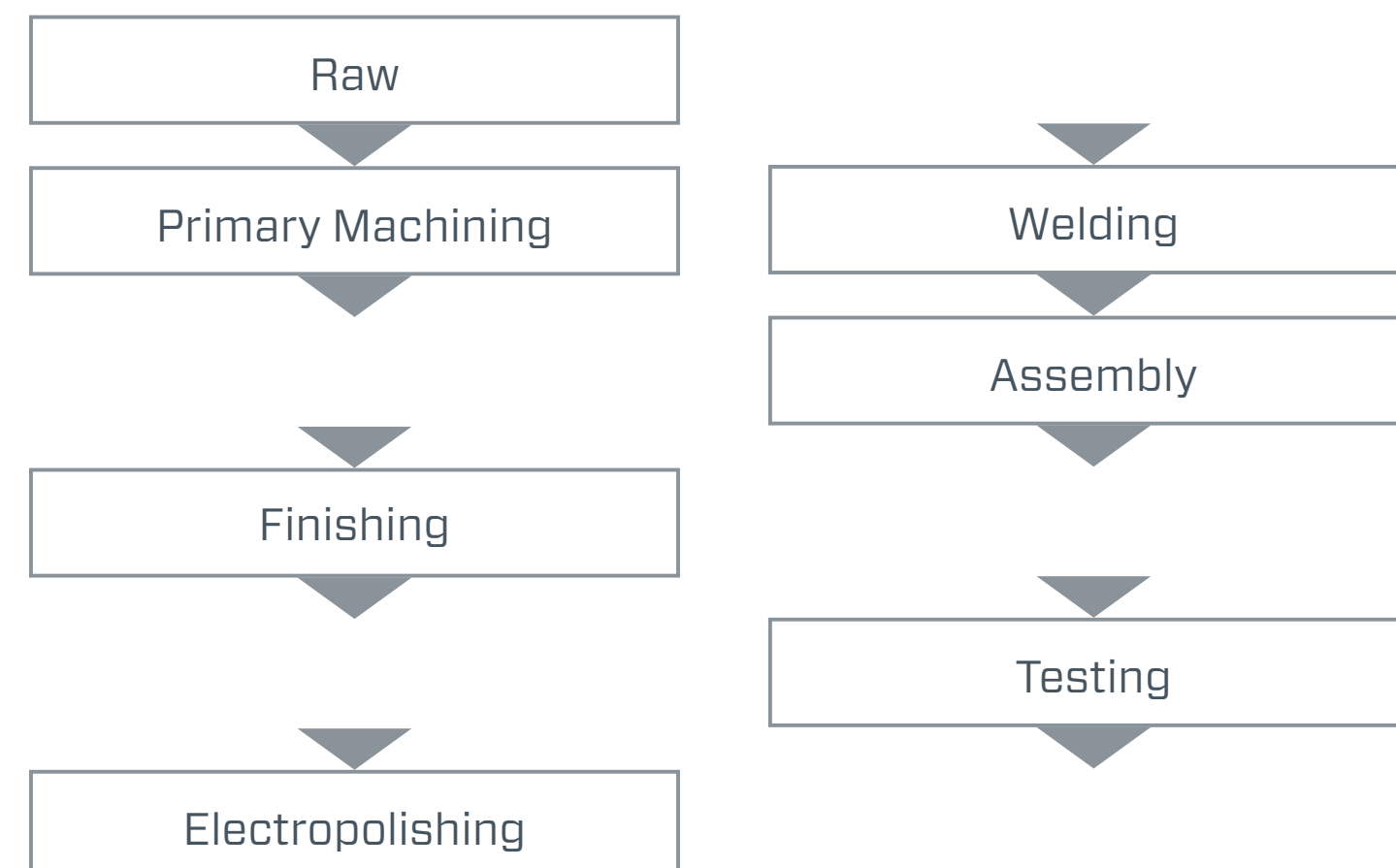




## Cleaning and Packaging Typical Cleaning Processes

Swagelok cleans material at several stages of its manufacturing process to ensure product integrity.

Some products move through a series of ultrasonic washings, some are solvent-cleaned, and some are cleaned via multistage water rinse tanks to a drying chamber. In SC-01 cleaning, all components of the washing and drying process are closed to the outside environment to limit particle contamination.





## Cleaning and Packaging Typical Cleaning Processes

**Type I** cleaning is performed after the component is initially processed and before it undergoes finishing operations. This type of cleaning includes bulk removal of machining contamination, such as coolant fluids and chips and other particulates.

**Type II** cleaning is performed after material finishing operations are complete and before the component is electropolished. This process removes visible contamination from finishing operations, such as residue from lapping and electrolytes. This type of cleaning is typically done by both chemical and mechanical methods.

**Type III** cleaning is performed after the component is electropolished and welded. Since this is the final cleaning prior to assembly, this process establishes the final part cleanliness level.

**Type IV** cleaning is the final nitrogen purge prior to packaging valves cleaned to the SC-01 standard. This process ensures product cleanliness after assembly.

**Packaging** Once products have been finished to our exacting standards, end connections are covered with clean caps and plugs to protect threads and other critical surfaces and to maintain cleanliness. We then package them to protect them from contamination and damage during shipping and storage.





## Our Commitment to Throughput and Repeatability

Throughput means you get more material through your manufacturing system faster, with less downtime. Repeatability means that the product you produce is the same, every time. With Swagelok, you get these benefits and more when you select products based on their suitability for your high-purity application. Innovations like our ALD valve enhance semiconductor manufacturing efficiency.

- Cobalt-based super alloy (UNS R30003) material for strength and corrosion resistance
- Optimized, patent-pending design for ultrahigh cycle life
- High-speed and repeatable actuation
- Suitable for thermal immersion operations
- Capable of valve opening or closing time of less than 5 ms





## Our Commitment to Quality, Reliability, and Safety

Swagelok's ongoing commitment to quality and reliability ensures our products last a long time, so you replace them less frequently. Our verification processes confirm the suitability of our products for use in the harsh extremes of the semiconductor industry—so you and your processes stay protected.





## Quality, Reliability, and Safety Commitment to Quality Assurance

Swagelok's quality processes and metrics assure the high value of our products. Our Swagelok Quality System (SQS) is compliant with the requirements of ISO 9001:2015. We employ various methods to verify the quality of our materials, components, and assemblies to ensure fitness for ultrahigh-purity manufacturing. This commitment to quality translates to fewer chances of leakage or interruption of the flow path, so your processes stay clean as well.

Our design process validates that our products are well-suited for the long cycle life demanded of products used in semiconductor manufacturing—even in highly corrosive or toxic environments.





## Quality, Reliability, and Safety

# Eddy Current Testing

Incoming stainless steel bar stock is checked via eddy current testing. Eddy current testing uses electromagnetic induction to detect surface flaws in conductive materials. A circular coil carrying current is placed in proximity to the steel. The alternating current in the coil creates a changing magnetic field that interacts with the steel and generates eddy current. Variations in the electrical conductivity or magnetic permeability of the steel, or the presence of flaws, will cause a change in eddy current and a corresponding change in the phase and amplitude of the measured current.

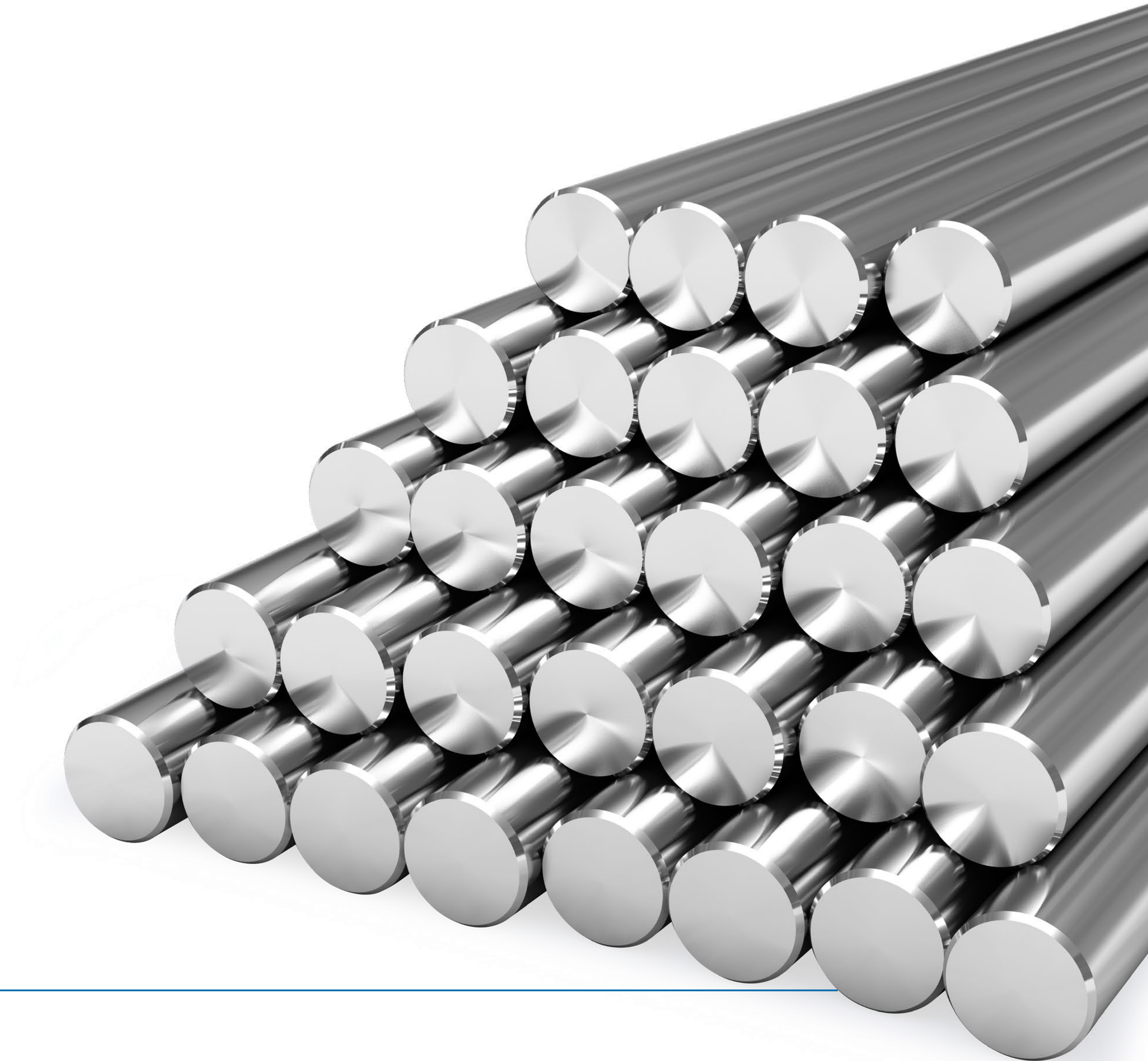




Quality, Reliability, and Safety

## Immersion Ultrasonic Testing

Once the steel is manufactured, it is subjected to immersion ultrasonic testing to detect internal flaws. With this testing method, short ultrasonic pulse waves are transmitted through a couplant, such as oil or water, to detect internal flaws in the stainless steel. The material being examined is coupled to the part by a liquid column or is totally submerged in the couplant. Because of the penetrating power and sensitivity of this test, small flaws deep in the steel can be detected.





Quality, Reliability, and Safety

## Critical Pitting Temperature (CPT) Testing

The Critical Pitting Temperature test can predict susceptibility of stainless steel to pitting corrosion by testing the entire wetted surface of the stainless steel (rather than just selected testing points) for a breakdown in the protective passive surface oxide layer of the stainless steel.

CPT values are the lowest temperatures at which pitting corrosion occurs during testing.

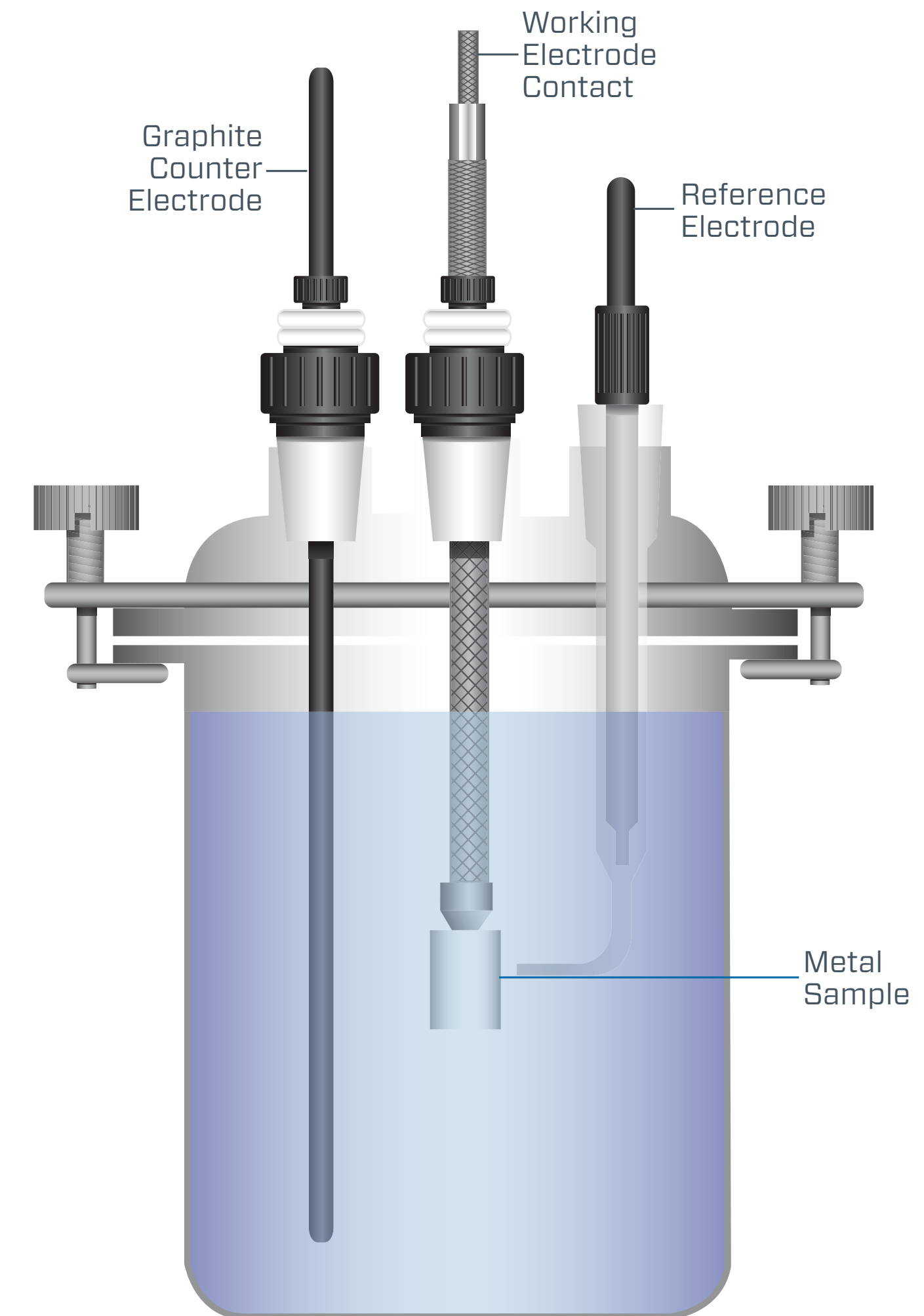




## Quality, Reliability, and Safety

# Performing the Critical Pitting Temperature (CPT) Test

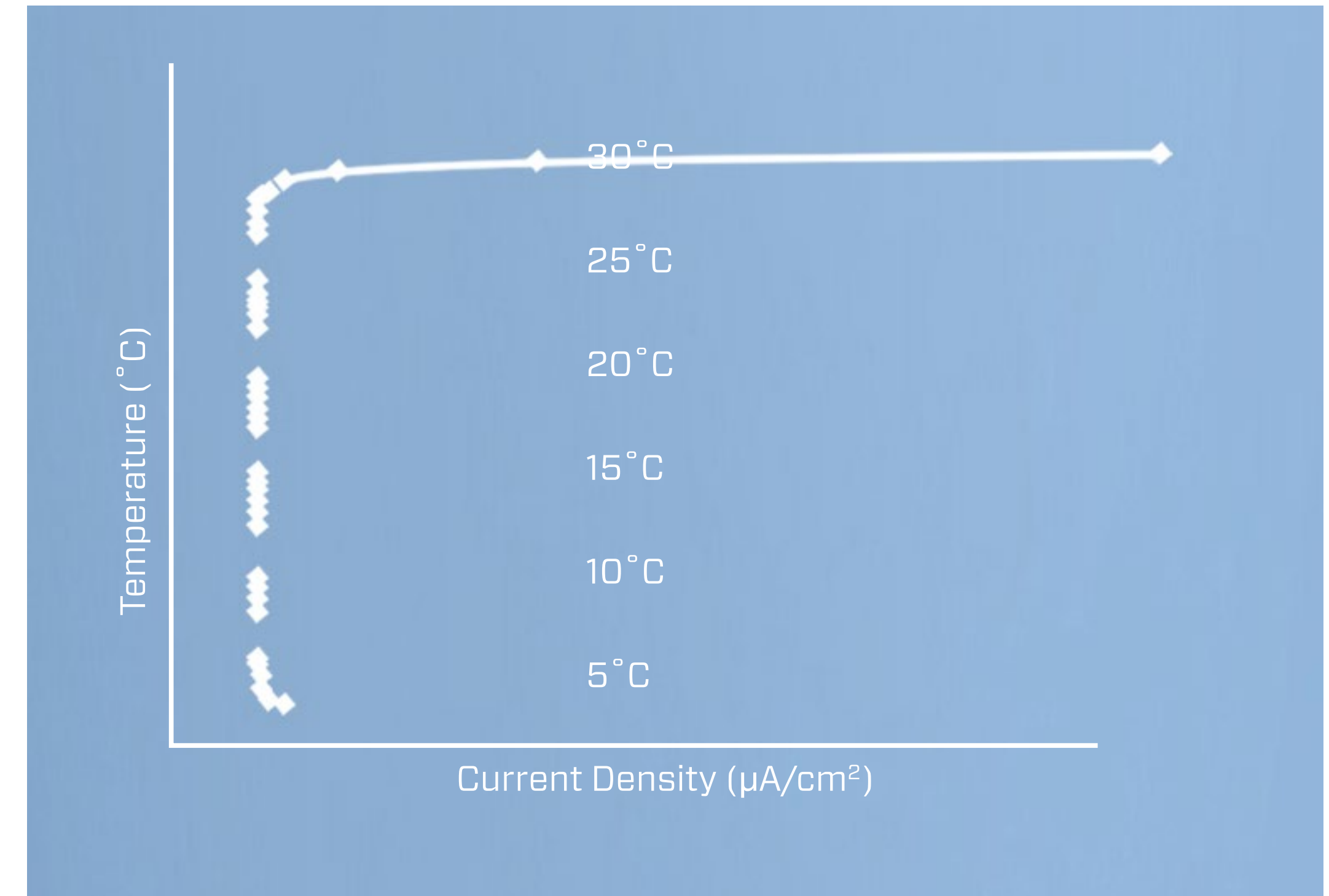
1. Masking is performed on actual product samples to isolate internal wetted surfaces to test exposure.
2. Component immersed in ASTM standard test solution.
3. A constant anodic potential is applied to an electric current across the part at an initial temperature of 0°C.
4. The temperature is ramped up at a rate of 1°C/min. Continue temperature ramp until the CPT is determined, a rapid increase in current density surpasses  $100 \mu\text{A cm}^2$  for at least one minute. This increase in current density demonstrates stable propagating pitting is occurring.
5. The sample is removed and visually examined to confirm the presence of pitting and absence of crevice or undermasking attack.



## Quality, Reliability, and Safety

# Interpreting the Critical Pitting Temperature (CPT) Values

The chart shows the relationship of temperature and current during a typical test. As the temperature ramp ensues, a stable passive behavior at low current density is exhibited. Upon breakdown of the passive surface, a rapid increase in current density is shown. Once the current density exceeds the  $100 \mu\text{A}/\text{cm}^2$ , the critical pitting temperature is determined.





## Quality, Reliability, and Safety Scanning Electron Microscope Inspection

Material can also be inspected with a scanning electron microscope equipped with X-ray spectroscopy, ensuring material integrity for safe, reliable performance.





## Get There With Installation Training

How to bring your quest for cleanliness full circle? With complete installation training from Swagelok. In ultrahigh-purity manufacturing, system components must work together to maintain leak-tight seals on toxic, corrosive fluids and gases while maintaining system integrity and purity under a wide range of operating conditions. Understanding how to optimize performance of Swagelok products with training in proper installation helps you meet your manufacturing goals and ensures your processes and personnel operate safely.





## Get There With Installation Training

Here are some of the topics covered in installation training:

- Technical product overview
- Proper technique and tools
- Inspection

You will participate in hands-on activities like these:

- Product assembly
- Verification of proper technique
- Certification program to ensure personnel are properly qualified





## Stronger Together

Take advantage of our distributor capabilities to strengthen your ultrahigh-purity manufacturing.

### Select the right products. ➤

Coordinate your project and connect with a single point of contact to authorized Swagelok sales and service centers worldwide. Product selection tools right where and when you need them, to help you choose the exact product for your job.

### Dynamic processes require continuously available products. ➤

Swagelok can provide customized inventory management services as well as just-in-time delivery for optimum stock levels.

### We're global. And local. ➤

Isn't it good to know you can count on Swagelok for availability and support? A world-class manufacturer with global representation and over 200 local sales and service centers. So expertise and support are always close at hand—wherever in the world you are.

### Learn more at [swagelok.com](https://swagelok.com). ➤





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