

# Your Guide to Sourcing Precision Metals for Bellows Manufacturing

Ulbrich Stainless Steels & Special Metals, Inc. is an industry-leading supplier of precision strip coil for manufacturers of high-performance bellows used in the aerospace, semiconductor, automotive, industrial, medical, and petrochemical markets. With over a century of expertise in precision metals, Ulbrich is a trusted partner for manufacturers seeking exceptional material quality, tight tolerances, and technical support.



*We Deliver Precision®*



We Deliver Precision®

ULBRICH.COM

## CAPABILITY WHITEPAPER

# Weldable & Formable Precision Metals for Bellows Applications

*Ulbrich delivers bellows manufacturing material engineered to withstand extreme conditions, including high temperatures, corrosive environments, and repeated flexing. Our metallurgical expertise ensures that every alloy we supply enhances fatigue life, weldability, and long-term durability, helping manufacturers produce better and higher performing bellows.*

### ALLOYS COMMONLY SUPPLIED TO MEET THE RIGOROUS DEMANDS OF BELLOWS

- AM350
- Titanium
- 304 Stainless
- 316 Stainless
- 321 Stainless
- Inconel 625
- Inconel 600
- Inconel 718
- Hastelloy C276
- Hastelloy X

### MATERIAL SOLUTIONS TAILORED TO YOUR SPECIFIC BELLOWS MANUFACTURING NEEDS

- Ulbrich’s metallurgical team assists with alloy selection and performance optimization
- Maintains tight tolerances & precise material thickness and width for superior performance
- Ensures consistent edge conditioning and uniform burr control for strong, leak-free welds
- Enhances production efficiency and product reliability with advanced precision processing
- Offers precision strip coil available up to 49 inches wide to accommodate both bellows types
- Helps customers navigate supply challenges with alternative alloys and high-quality stock

### MARKETS BENEFITTING FROM OUR INDUSTRY LEADING PRECISION ROLLED STRIP COIL



### PARTNER WITH ULBRICH FOR HIGH-QUALITY MATERIALS IN BELLOWS MANUFACTURING

**METALLURGICAL SUPPORT**

**PRECISION PROCESSING**

**EDGING & SLITTING EXPERTISE**

**SUPPLY CHAIN MANAGEMENT**



**CONTACT US TODAY**

# Enhancing Bellows Performance with Precision Metals

Bellows are critical components used in a wide variety of industries, including semiconductor, medical, industrial, petrochemical, automotive, and aerospace applications.

The diversity of these applications is reflected in the diversity of bellows themselves. One bellow can be vastly different from the next—requiring entirely different alloys, properties, and manufacturing processes—yet they all share one fundamental requirement: they must work flawlessly. Their roles are too essential for failure.



Selecting the right alloy and supply chain partner for manufacturing bellows is crucial to ensuring durability, performance, and cost-effectiveness. This whitepaper explores common applications, alloys, key material properties, and other factors that bellows manufacturers must consider when procuring optimal material.

For bellows to achieve peak performance, material components must exhibit exceptional weldability, formability, uniformity, temperature resistance, corrosion resistance, and more. Ulbrich provides custom-engineered precision metal to meet the stringent requirements of even the most challenging applications.

## COMMON BELLOWS APPLICATIONS

Bellows are used in a wide range of industries due to their ability to accommodate movement, absorb vibration, and compensate for thermal expansion. Key applications include:

### SEMICONDUCTOR INDUSTRY

Bellows are used in vacuum chambers for precise motion control and to maintain a contaminant-free environment.

### MEDICAL INDUSTRY

Bellows are critical in devices like ventilators and surgical robots, where precise and reliable motion control is essential.

### INDUSTRIAL APPLICATIONS

Bellows are used to absorb thermal expansion and contraction in piping systems, ensuring the integrity and safety of the system.

### PETROCHEMICAL INDUSTRY

Bellows are used in cryogenic and high-temperature processing systems to handle extreme temperature fluctuations and ensure leak-free operation in corrosive environments.

### AUTOMOTIVE INDUSTRY

In exhaust systems, bellows manage thermal expansion and reduce vibration, enhancing the durability and performance of the system.

### AEROSPACE INDUSTRY

Bellows are used in fuel lines, exhaust systems, and other high-flexibility, high-durability parts, where they must withstand extreme conditions. This includes water management systems that use bellows to prevent potable and wastewater fluid lines from leaking under varying levels of pressure, thermal expansion, and vibrations.

# TYPES OF BELLOWS

Bellows can be broadly classified into two types based on their manufacturing process: formed bellows & welded bellows. Each type offers unique advantages suited to specific applications.

## FORMED BELLOWS

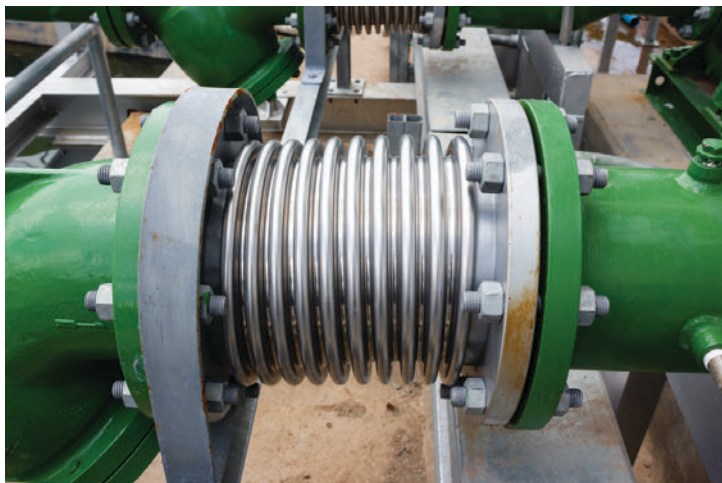
Formed bellows are manufactured by rolling precision strip material into a tube, welding the seam, and then applying a forming process to shape the tube and create the necessary corrugations. Traditionally, mechanical forming methods, such as roll forming or mandrel expansion, have been widely used, but hydroforming is emerging as an alternative.

### Hydroformed Bellows: An Emerging Technology

Hydroforming uses high-pressure fluid to expand the welded tube within a die, forming the characteristic bellows profile. This process can reduce mechanical stress, improve uniformity, and enhance fatigue resistance compared to traditional forming techniques.

### Manufacturing Process (Hydroformed Bellows)

- A welded metal tube is placed inside a die.
- High-pressure fluid expands the tube, shaping it to match the die's contours.
- The ends are trimmed and prepared for integration into larger systems.



## WELDED BELLOWS

Welded bellows are constructed by precision-welding multiple thin diaphragms together, creating a highly flexible, accordion-like structure. These are typically smaller in size and used in precision applications where tight control over movement and pressure is critical.

### Manufacturing Process

- Thin metal diaphragms are stamped or laser-cut from precision strip material.
- The edges are welded together using laser or TIG welding to form a continuous, flexible structure.
- The number of diaphragms determines the overall length and flexibility of the bellows.

## KEY DIFFERENCES AND APPLICATIONS

The two types differ in manufacturing methods, performance characteristics, and applications. Welded bellows, made by joining individual diaphragms, provide exceptional leak tightness, flexibility, and fatigue resistance, making them ideal for precision applications in aerospace, medical, & semiconductor industries. Common metals include AM350, Inconel 625, & titanium.

In contrast, hydroformed bellows, formed from a single metal tube, are larger, more durable, and suited for high-pressure industrial applications. While generally less flexible than welded bellows, they offer strength and reliability in automotive exhaust systems, industrial piping, and some high-temperature aerospace parts. Typical alloys include 304, 316 and 321 stainless.

# CRITICAL MATERIAL PROPERTIES FOR BELLOWS

Selecting the right material is essential to ensuring durability, flexibility, and long-term performance. Several key material properties influence how well bellows can withstand operational stresses, such as its grain size, surface finish, weldability, and resistance to low-cycle fatigue, high-temps, and corrosion.

## GRAIN SIZE & FINISHES FOR LONGEVITY

Grain size plays a crucial role in determining the mechanical properties of the material. A finer grain structure enhances strength, flexibility, & fatigue resistance, contributing to longer service life. Maintaining a smooth surface finish helps reduce stress concentrations & supports overall performance in demanding bellow applications.

## LOW-CYCLE FATIGUE (LCF) RESISTANCE

One of the most important performance factors in high-flex applications such as bellows is LCF because it determines how many deformation cycles a part can endure before failure. Bellows used in dynamic environments, like aerospace or industrial fluid systems, must be made from materials that can withstand repeated stress without cracking or losing flexibility.

## CORROSION RESISTANCE

Bellows are often exposed to harsh chemicals, moisture, and other corrosive elements, making its ability to withstand deterioration a key consideration. Materials must provide strong resistance to general corrosion and in many cases offer superior protection against pitting, oxidation, as well as chemical degradation in aggressive environments.

For applications involving exposure to seawater, acids, or extreme industrial conditions, selecting a bellow material with high corrosion resistance ensures longevity and consistent performance.

## WELDABILITY CONSIDERATIONS

Since bellows are often subjected to welding processes, how weldable a material is plays a role in determining the bellows performance. Some alloys are inherently easier to weld than others, and selecting a material with compatible chemistry is just as important as grain size for ensuring strong, defect-free welds.

## HIGH-TEMPERATURE RESISTANCE

Bellows used in applications such as aerospace, exhaust systems, and industrial processing must withstand extreme temperatures without losing structural integrity. Materials must offer excellent high-temperature performance, maintaining their mechanical properties even in prolonged exposure to heat.

## CONCLUSION ON MATERIAL PROPERTIES

By carefully considering all these properties, manufacturers can ensure that bellows perform optimally in their intended environments, whether they require superior weldability, extended fatigue life, or enhanced protection against extreme temperatures or corrosion.

*Now that we've discussed common bellows applications, manufacturing processes, and material properties, let's put it all together by discussing why certain alloys are better suited for certain applications and types of bellows.*

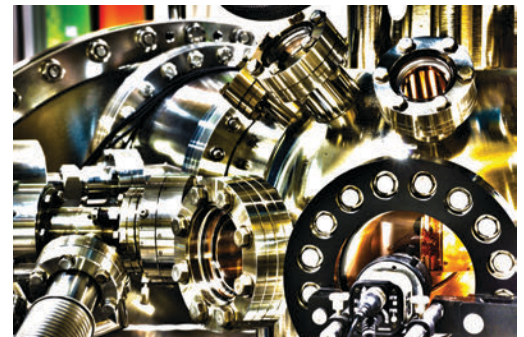
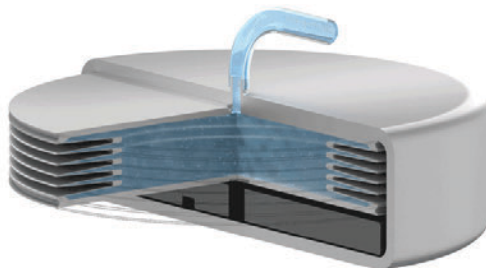
# WELDED BELLOWS: WHY AM350, INCONEL 625, AND TITANIUM?

They require materials that can handle repeated welding, maintain their mechanical properties under extreme conditions, and provide superior fatigue resistance.



## 1. WELDABILITY & HEAT RESISTANCE

- **AM350:** A precipitation-hardened stainless steel with excellent corrosion resistance and strength. It can maintain stability even after multiple weld passes.
- **Inconel 625:** A nickel-based superalloy that offers outstanding performance at high temperatures and resistance to oxidation, crucial for aerospace & semiconductor parts.
- **Titanium:** Lightweight and highly corrosion-resistant, making it suitable for medical and aerospace applications. Also biocompatible, which is important for implantable devices.



## 2. FATIGUE LIFE & STRENGTH

Welded bellows often operate in environments requiring low-cycle fatigue resistance, where materials must endure repeated stress cycles without failure. These alloys maintain their mechanical integrity over long fatigue cycles due to their superior strength-to-weight ratio & high resistance to microcracking at weld joints.

## 3. CORROSION & OXIDATION RESISTANCE

**AM350** and **Inconel 625** are ideal for environments where extreme temperatures and corrosive chemicals are present, such as aerospace fuel systems and semiconductor vacuum chambers.

**Titanium's** corrosion resistance makes it perfect for harsh environments like medical implants (where biocompatibility is also crucial) and certain aerospace applications.

## 4. PRECISION FABRICATION & TIGHT TOLERANCES

Welded bellows require high precision in diaphragm forming & welding. These materials provide excellent control over dimensional stability & repeatable performance after welding.

# FORMED & HYDROFORMED BELLOWS: WHY AUSTENITIC STAINLESS STEELS (304, 316, 321)?

They rely on metal that can be easily shaped into corrugations while maintaining uniformity & strength.

## 1. FORMABILITY & DUCTILITY

**304, 316, & 321 stainless steels** have excellent formability, allowing them to be formed into seamless bellows without excessive thinning or cracking. Austenitic stainless steels have a natural work-hardening ability, which means they retain good strength after forming.

## 2. UNIFORM THICKNESS & STRUCTURAL INTEGRITY

Forming exerts high internal pressure on the metal tube, expanding it into the desired shape. Austenitic stainless steels have high elongation properties, meaning they can be stretched without significant loss of material thickness.

## 3. CORROSION RESISTANCE & ENVIRONMENTAL DURABILITY

**304 & 316 stainless steels** offer good corrosion resistance in industrial and automotive environments, making them ideal for exhaust bellows and chemical processing applications. **321 stainless** includes titanium stabilization, which helps resist intergranular corrosion at high temperatures, making it suitable for aerospace and automotive exhaust systems.

## 4. Cost & Availability

Austenitic stainless steels are more cost-effective than high-performance alloys like Inconel or titanium, making them a preferred choice for large-scale industrial applications. These metals are more readily available in the wider strip widths required for forming and hydroforming, unlike more specialized aerospace alloys.



## WHY MATERIAL CHOICE MATTERS

**Welded Bellows** require high-strength, fatigue-resistant, weld-friendly materials like AM350, Inconel 625, and titanium because the welding process introduces heat-related stress, & these materials retain their properties after welding.

**Hydroformed Bellows** benefit from formable, ductile, and corrosion-resistant steels like 304, 316, and 321 austenitic stainless since they can be expanded into bellows shapes without cracking & maintain their integrity after forming.

# WHY ULBRICH IS A PREMIER PARTNER FOR BELLOWS MANUFACTURERS

As a trusted partner for bellows manufacturers, we provide high-quality, precision-engineered materials that enhance both performance and durability. What sets us apart is our metallurgical expertise, precision processing, and ability to offer material solutions that optimize your manufacturing efficiency and product longevity.

A key differentiator is our metallurgical support, offering customers access to alternative alloys that may not be readily available elsewhere but are maintained within our extensive inventory. Additionally, we'll work with certifications from other suppliers to match required properties and assist in failure analysis, diagnosing issues such as chemistry imbalances, laminations, and material suitability for specific environments.

Maintaining tight tolerances is another critical factor in bellows manufacturing, and Ulbrich ensures consistent material thickness and width for superior performance. Many bellows require light-gauge materials in wide widths, and we meet this demand with stock availability up to 49 inches wide—offering a level of supply capability that few competitors can match.



## ADDED-VALUE PROCESSING AND SLITTING CONSIDERATIONS

Beyond selecting the right alloy and rolling the material to tight gauge tolerances, Ulbrich's valuable processing capabilities play a pivotal role in ensuring defect-free manufacturing for bellows applications.

For welded bellows, precise stamping and laser-welding of diaphragms requires consistent edge conditioning to enable seamless manufacturing. Poor edge conditioning, such as burr formation, can lead to costly complications, including material getting caught in the presses and subsequent production inefficiencies.

For edge-welded formed and hydroformed bellows, maintaining a uniform burr is essential for strong welds and reliable performance. Any inconsistency in slitting can result in defects such as blowouts or leakage—issues that can compromise the integrity of the bellows once subjected to rigorous leak testing. Our expertise in precision slitting ensures that materials maintain uniform edges, with or without a burr, minimizing the risk of failure and optimizing product reliability in critical applications.

By combining high-quality alloys with our tight manufacturing tolerances, years of metallurgical expertise, and advanced processing capabilities, Ulbrich provides manufacturers with the ideal materials to meet stringent industry standards. Whether for aerospace, automotive, medical, or semiconductor markets, Ulbrich's commitment to precision and innovation ensures that manufacturers receive metals engineered for long-lasting, high-performance bellows.

For more information on material selection and availability, contact us today! [www.ulbrich.com](http://www.ulbrich.com)

# Knowledgeable Leadership in Metals Selection

## ALWAYS LOOKING FOR WAYS TO INNOVATE AND IMPROVE UPON BELLOWS APPLICATIONS



In addition to our state-of-the-art capabilities in rolling, slitting, and annealing, Ulbrich is continuously testing, researching, and analyzing alloys and their chemical and mechanical properties to maximize performance potential. What does this mean for you? It means when you partner with Ulbrich, you not only get the best of the best in personnel, process, and product—you also get a promise of a team that truly cares about making your bellows part as consistently successful and effective as possible.

## GLOBAL REPRESENTATION WITH SERVICE & DISTRIBUTION CENTERS LOCATED WORLDWIDE

Ulbrich Stainless Steels & Special Metals, Inc., is a family owned company in its fourth generation of leadership. Established in 1924, Ulbrich has become a critical supplier of stainless steel & special metals to various industries throughout the globe. During this time, we have participated in the development and manufacturing of hundreds of innovative applications. With industry leading Dimensional Control, real time gauging and Statistical Process Control (SPC), a large variety of specialty alloys, and the best customer service available, we strive to produce and distribute the highest quality materials to you. Ulbrich is comprised of a series of manufacturing divisions that supply specialty strip and foil, as well as precision flat, fine, round, and shaped wire, all with local management and all designed to provide custom metal products to satisfy the needs of bellows manufacturers around the world.

## YOU HAVE IDEAS. WE HAVE RESOURCES. PARTNER WITH LEADING EXPERTS.

With Ulbrich's world-class Development Innovation Team, you can gain access to product specialists and quality metallurgists, each with expertise that is best-suited for your unique raw material needs. Our team can deliver custom material solutions to maximize the performance of your application. Talk to a specialist today to learn about what finishes, edge capabilities, mechanical properties, packaging and lengths we can offer for your application! Learn more about our Development Partnership online at [www.ulbrich.com/company/development-partnership](http://www.ulbrich.com/company/development-partnership)

Contact Ulbrich For Your Bellows Manufacturing Needs!

[info@ulbrich.com](mailto:info@ulbrich.com) | **800-243-1676**

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# Our Industry Leading Capabilities

**TAILORED TO YOUR EXACT SPECIFICATIONS**



## OVERVIEW OF MANUFACTURING

Our state-of-the-art equipment, technology, and staff make us the go-to stainless steel and special metals producer for numerous manufacturing markets, including the medical, aerospace and automotive industries.

## ROLLING TOLERANCES

Our largest H-mill can handle incoming strip material up to .125" thick, while our smallest Z-mill can roll foil as light as .00039": an order of magnitude thinner than a human hair.

## SLITTING & EDGING

From Round to Square edge, our slitters have the ability to separate a wide strip into "mults" or narrower strips to achieve your desired width with as much minimized burr as possible.

## ANNEALING

Utilizing hydrogen, nitrogen, and argon controlled atmospheres, we properly anneal all the alloys we offer to satisfy the most demanding specifications of the aerospace, medical, and nuclear industries.

## MATERIAL PROPERTIES

From Bright to Dull or Quarter Hard to Extra Full Hard, Ulbrich has the ability to control your desired surface finish and mechanical properties of your Precision Strip & Wire products.

## COATING & PLATING

Based on your exact requirements, we expertly apply protective coatings with various thicknesses, adhesion properties, colors, and opacity to ensure your product is successfully brought to completion. Additionally, our multiple plating lines, first-rate production capabilities, and expert metallurgists can handle any plating needs you have.

## PACKAGING

With production and shipping capabilities spanning the entire globe, we are able to accommodate steel and metal product packaging and transit to almost any international destination.

# Strip Coil Rolling & Slitting Capabilities



## OUR ROLLING TOLERANCES

Our rolling divisions, Ulbrich Specialty Strip Mill (USSM) and Ulbrich Precision Alloys (UPA), provide specialized strip metal coil, not readily available from others, engineered to exacting specifications. Cold Rolling is the cornerstone of Ulbrich, and the heart of the conversion process. Rolling at Ulbrich is considered “cold rolling” because we do not increase the temperature of the material before we roll it. Our ability to deliver a customized and consistent product within precision and ultra precision tolerances allows us to provide our customers the material they need to create enhanced products and processes. The Ulbrich strip mills' diversity of equipment and experienced staff enables us to establish robust processes capable of supplying a precise and consistent product for use in a wide variety of applications across multiple industries.

### ULBRICH ROLLED STRIP SIZE RANGES

Thickness Range: .0003" – .125" (0.0075 – 3.175mm)

Thickness Tolerance (Standard): +/- 3% standard  
*(Tolerances better than 1% can be achieved based on criteria)*

Thickness Tolerance (Extreme): +/- 1%

### PRECISION ROLLED STRIP COIL SIZE RANGES

Width Range: .016" – 48" (0.406mm – 1219mm)

Width Tolerance (Standard): +/- .005" (+/- 0.127mm)

## THE SLITTING PROCESS

Slitting can serve as both the initial and final operation in the conversion process at Ulbrich. All of the slitters are similar in concept and operation, but vary greatly in size. Our larger machines are dedicated to slitting the heavy gauge incoming coils up to 54" wide to mults used for re-rolling. At the other end of the process, slitting is used to separate a material at finish gauge and temper into the width ordered by the customer. Apart from width: edge condition, coil inner diameter, coil support, coil size, interleaf and accumulation method are all characteristics of the final product that are realized during final slitting. Our operators will make adjustments to the clearance as they are preparing to slit the material in order to minimize the edge burr as much as possible. Once a coil is slit to final width, it can be packaged and delivered to the customer.

### EDGING AVAILABLE

#1 ROUND EDGE



#3 SLIT EDGE



#5 SQUARE EDGE



### SERVICE CENTER SLIT COIL SIZE RANGES

Width Range: .065" – 52" (0.8128mm – 1320mm)

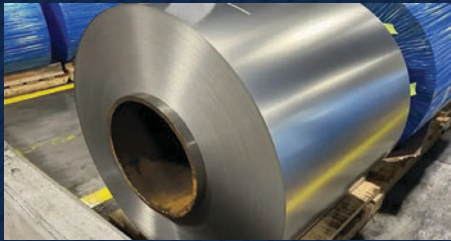
Width Tolerance: +/- .005" (+/- 0.127mm)

# Wide-Width, Light-Gauge Precision Strip Rolled for Peak Performance

From titanium and stainless steels to high-performance nickel and cobalt alloys, Ulbrich provides the right material, rolled to precise specifications, to meet the most demanding requirements in aerospace, medical, semiconductor, automotive, and many other critical industries.

## Unmatched Precision Rolling Capabilities

**AVAILABLE AT ULBRICH PRECISION ALLOYS AND ULBRICH SPECIALTY STRIP MILL**



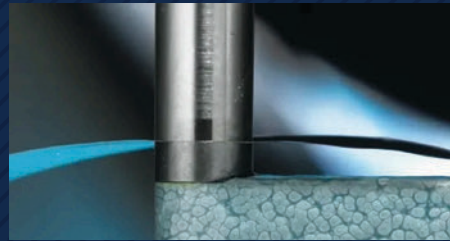
### Wide Width

WIDTH RANGE:

**.016 – 48”**

(.406 – 1219 MM)

Tolerance: +/- .005" (+/0.127mm)



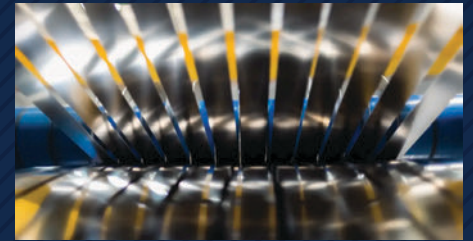
### Light Gauge

THICKNESS RANGE:

**.0003 – .125”**

(.0075 – 3.175 MM)

Tolerance: +/- 1-5%



### 165+ Alloys

SPECIALTY ALLOYS AVAILABLE

Including titanium, stainless steel,  
nickel-based & other special metals

## Wherever You Are in Product Development, Ulbrich Can Be Your Strategic Partner

Whether you're developing a new product or ramping up full-scale production, our metallurgical expertise, advanced manufacturing facilities, and commitment to engineered excellence help you move faster, minimize risk, and deliver higher-performing parts.



### BUILT FOR CRITICAL APPLICATIONS

Edge-Welded & Hydroformed Bellows  
Heat Shields & Thermal Insulation  
Nuclear Reactors & Land-Based Gas Turbines  
Plate Heat Exchangers & Titanium Shims  
Flexible & Heater Circuits  
Medical Devices & Implantable Components



**START BUILDING WITH PRECISION**

# Manage Global Risk by Reshoring Your Supply Chain

In today's volatile supply chain environment, manufacturers are under increasing pressure to reduce risk, maintain consistent quality, and improve lead times. Find stability, speed, and strategic control with Ulbrich's sourcing strategies, tailored to your unique needs.

Need metal melted and manufactured in the U.S. to avoid tariffs? We offer it. Prefer global sourcing? We're a domestic partner that can manage its complexity for you. Unsure which? We can help you find the most effective path forward.

## Why Leading Manufacturers Choose Ulbrich



### MATERIALS WE SUPPLY

We provide leading manufacturers Precision Strip, Shaped & Fine Wire in 165+ specialty alloys, including:

- Stainless Steels (300 & 400 series, PH grades)
- Nickel & Cobalt Alloys (Inconel®, Hastelloy®, Haynes®)
- Titanium & Titanium Alloys

- **Hybrid Sourcing Model:** Global and domestic material access with regional reliability.
- **Custom-Engineered Material:** Tight tolerances, tailored specs, and consistent quality.
- **Speed & Flexibility:** Support for rapid prototyping and quick-turn production.
- **Inventory Optimization:** Buy in smaller, more frequent batches to improve cash flow.
- **Expert Support:** From metallurgical guidance to supply chain planning, we help you navigate complex challenges and stay production ready.



### INDUSTRIES WE SUPPORT

- Automotive
- Aerospace & Defense
- Energy & Power Generation
- Medical Devices
- Oil & Gas
- Industrial Components
- Electronics & Semiconductors

### BRIDGING GLOBAL REACH WITH DOMESTIC SUPPORT

Whether you're seeking tariff relief, shorter lead times, or more control over critical inputs, Ulbrich can help. Our domestic reroll mills and service centers are backed by a global sourcing network, giving you options without the headaches.



**We Deliver Precision®**



**DISCOVER HOW ULBRICH CAN HELP YOU  
CREATE A MORE RESILIENT SUPPLY CHAIN**