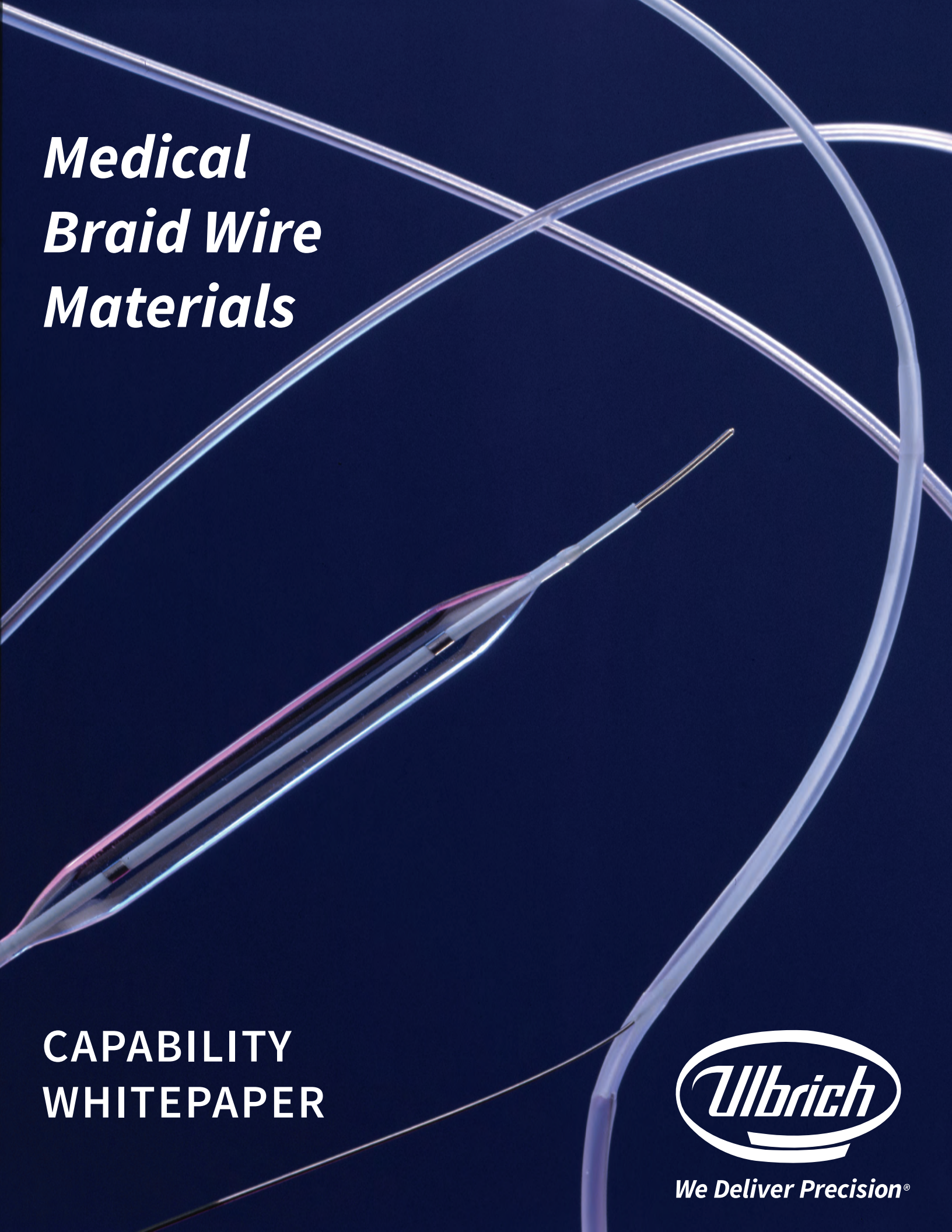
Medical Braid Wire Materials



CAPABILITY WHITEPAPER

Ulbrich

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CAPABILITY SHEET

Medical Braid and Coil Wire for Catheters

OUR TEAM OF METALLURGISTS & CATHETER PRODUCT EXPERTS CAN GET THE MATERIALS YOU NEED, BUILT TO EXACTING SPECIFICATIONS

ALLOYS

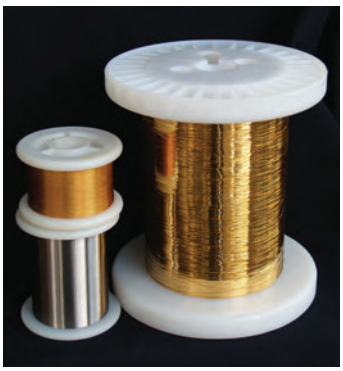
- 304V/304LV
- 316LVM
- Nitinol
- Tungsten
- L605
- MP35N
- Silver Plated Copper
- Copper Beryllium

FORMS

- Flat, Round, Shaped Cross-Sections

HIGH-QUALITY STAINLESS STEEL & NICKEL ALLOYS FOR CATHETERS OF ANY SHAPE & SIZE

With serious medical consequences at hand, Ulbrich takes pride in providing medical device manufacturers with the metals they need to create supremely functional catheters. Combining our vast knowledge in R&D with accuracy and high-precision winding, we're committed to giving you what you need to manufacture first-rate catheters for doctors and patients. And because we produce braid and coil reinforcement wire in various alloys, we're experienced in making alloys that can be used in all types of catheter products, including braided catheters and shafts, coiled shafts, micro-catheters, EP catheters, as well as vascular catheters.



STREAMLINED WIRE ALLOY SOLUTIONS ARE AVAILABLE ANYWHERE

Ulbrich's global support structure guarantees streamlined solutions for all our customers, no matter how big or small they might be. With our widespread physical presence throughout the world – which includes twelve locations in five countries across North America, Asia, and Europe – it's easy for us to provide industry-leading services for most manufacturers. From vendor managed stock programs and excellent lead times, to industry expertise and rapid deliveries, we ensure precision in our process from start to finish.

DEVELOPMENT PARTNERSHIP *BRAID WIRE ACCELERATOR® PROGRAM*

At Ulbrich, we understand medical device development timelines continue to be reduced. The need for device designers to iterate quickly is accelerating and rarely supported by the supply chain. To better serve our customers' ever increasing requirements, we have developed our fine wire stocking program. *(See pages 14–15)*

Alloys for Medical Manufacturing

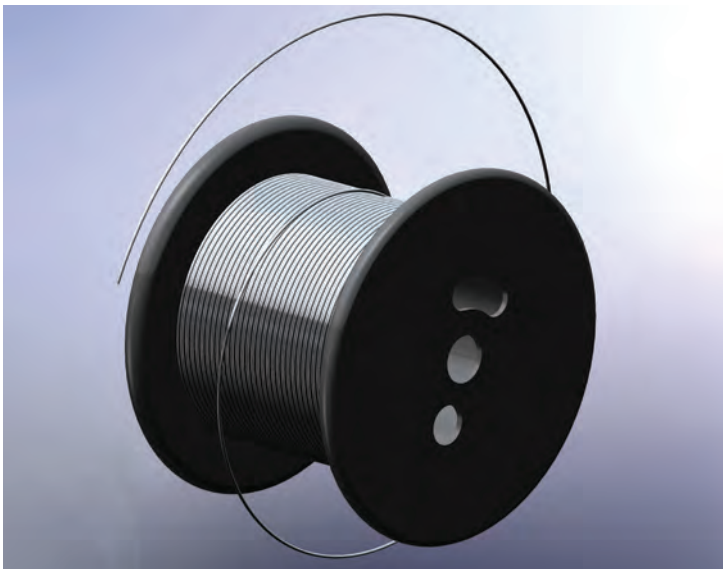
THINGS TO CONSIDER WHEN EVALUATING WIRE ALLOYS FOR YOUR MEDICAL APPLICATION

WHAT ARE THE PROPERTIES TO CONSIDER?

Here is the short answer: any decision on chemical, mechanical and physical properties of metal alloys is highly dependent on what task the medical device will perform and the environment in which it will operate.

End-use applications dictate every single decision that goes into selecting an alloy, determining its shape and size and quantifying the amount of material needed. Other properties medical manufacturers and buyers should consider might be: atomic, electrical, environmental, magnetic, radiological, manufacturing properties such as castability or machinability, and even perhaps thermal properties of the material.

When specifying an alloy for your medical application, correct and uniform chemical properties should be decided upon early in the metal selection process. Taking careful steps to select the right chemical makeup of an alloy allows precision re-rollers or other metal suppliers to source accurate, high quality raw material—that has been smelted or manufactured long before arriving at our loading bays. At Ulbrich, Engineers, Product Managers and seasoned Sales professionals work together to communicate the best route to take in terms of material selection.

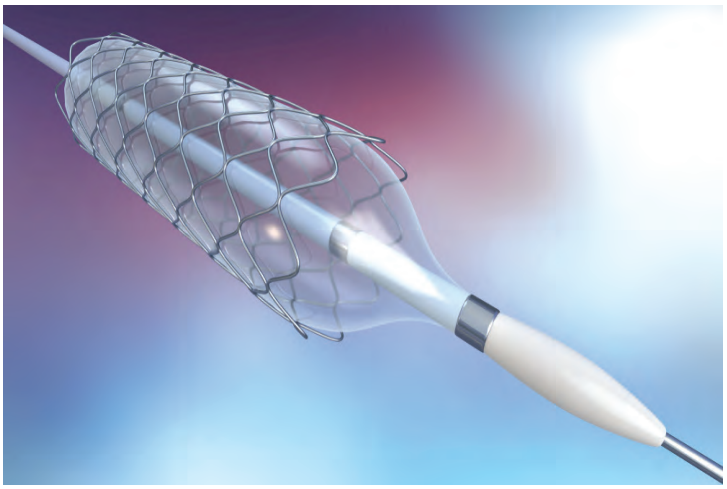


At Ulbrich Specialty Wire Products in Westminster, SC, where most of our medical device customers procure precision round and flat wire, we have medical manufacturing and metallurgical experts who help our customers select and procure the right material with the right properties based on their specific application demands. The most common mechanical properties are high strength and dimensional control for medical braid wire applications. Dimensional control, surface smoothness and elongation have also become of high importance for Mandrel applications.

Mechanical properties and oxide layers related to the specialty metal Nitinol, which is a shape-memory alloy, are known to be critical factors in the medical device industry these days.

Biocompatibility, or the capacity of the human body to adapt to contact with metal such as Titanium, is also a factor that medical manufacturers must often consider. For example, Titanium rods applied in oral surgeries bind to human flesh. The Titanium rods are permanently and effectively set in place making their biocompatibility extremely important to prevent rejection, corrosion, or infection. Titanium is highly biocompatible so it is often used in medical manufacturing such as dental implants, allowing patients to heal quickly and to use their jaw/teeth as if nothing happened.

Many medical manufacturers use a spring temper flat, round or custom shaped wire for their application. Different required characteristics that might be desirable based on manufacturing process or end use might warrant annealed, full-hard, half-hard, and quarter-hard wire which can be provided upon request from wire manufacturers.



The harder the temper, the more rigid the structure will be. This gives a good torque response to the device, which is also known as “torquability”. For example, in the production of catheters, special maneuverability is the key to success, making torquability of the material used in their production a very important requirement.

Catheters are medical devices that can be inserted in the body to treat diseases or perform surgical procedures. Mechanical properties play a huge role in the selection of metal for making catheters, since they are extruded over specialty metals like Nitinol to create catheters. Medical device customers must also decide whether to go with coiled-enforced or braid-enforced catheters for their application. In the production of catheters, many customers are now using Nitinol for coiled catheters used in especially sensitive surgeries where precision is paramount, like neural or cardiovascular surgeries.

WHAT ARE THE DIFFERENT METHODS FOR ENSURING MATERIAL QUALITY FOR MEDICAL WIRE AND WHAT DO THEY ACCOMPLISH?

Methods for ensuring quality stainless steels and special metals for medical wire should be a big focus, not only for the quality assurance team at your organization, but it should be an expectation of yours that it is the utmost priority of your medical rolling mill.

Continuous dimensional data collection (SPC data) should be collected as the metal runs through the mill because it will improve consistency in the performance for your manufacturing process as well as the medical device. Working closely with metal manufacturers who have trained metallurgists on staff who have knowledge of how metal is shaped and sized at the miniscule, mathematical level is extraordinarily advantageous for medical device manufacturers. This type of quality control ensures that defects are less likely and therefore, time and energy savings are benefitting your medical device or component business and streamlining your production while reducing scrap, waste and failure. Most of all, dimensional data collection assures that materials are within your specifications and meet all regulatory and manufacturing requirements.

Surface cleanliness is another major factor that has an impact on improving or degrading material performance in demanding medical applications. The methods to ensure cleanliness can never be stringent enough, because people’s lives are literally on the line. Precision strip, flat wire and round wire must be as particulate-free as possible to ensure peak results, because anything else could be catastrophic.

Quality Control Coordinators, Machine Operators and Helpers at Ulbrich are continuously inspecting each work order with vigorous attention to detail. Team communication and collaboration are paramount to ensuring quality throughout the supply chain. When selecting a materials partner, you should work to understand if they have the same level of commitment to quality up and down the organizational chart as you would expect. Compliance with the latest ISO certifications are well and good, however, to meet the material needs of medical device customers, special precautions and utmost care should not only be standardized in the process, but engrained in the culture.

Personal Protective Equipment (PPE) is only step one to keeping material free and clear of contaminants. Custom barriers, guards, and other means of contaminant prevention should be installed on the machinery at every stage of material production to protect metal in progress (as well as the Machine Operators) from being compromised. This ensures that the material you receive is ready for, and has been manufactured to, the same level of cleanliness and attention to quality and performance that you set for yourself as a medical manufacturer.

A method on the front end of the manufacturing process starts with purchasing. Buying material from qualified sources and reputable vendors is essential. The chemistry makeup of the material must be carefully inspected while at the same time, inclusion rates should be as low as possible (non-existent in a perfect world).

In choosing a supplier and an alloy, medical device customers must seek those sources who sell materials with consistent and undeviating mechanical properties which are paramount to processing medical wire. Manufacturing sources as well as production methods are equally vital in the supply chain to attaining success in the world of high-tech medical devices.

Lastly, tedious spooling methods to avoid tangles during production are also of high importance. When medical device customers go to use bulk, Steeger or Wardwell bobbins, they do not want any breakages due to tangling wires. With round wire as thin as 0.00075" for nitinol and stainless steel alloys, tangling can cause massive strain on medical device production. Ulbrich cautiously wraps wire on spools with the next operation in mind, and we then ask for feedback on the performance of the spooling.

WHAT ENVIRONMENTAL OR CONTEXTUAL FACTORS ARE DEVICES SUBJECTED TO THAT CAN AFFECT MATERIAL SELECTION?

Will the device be implanted in the body, or how long will the device be in there? Biocompatibility and response to blood is an essential factor here. MRI Compatibility may also be required depending on your application.

HOW IMPORTANT ARE THE CORROSION RESISTANT PROPERTIES OF STAINLESS STEEL OR OTHER SPECIAL METAL WIRE FOR MEDICAL DEVICE MANUFACTURING?

Very Important. For example, 304V stainless steel wire has been vacuum arc remelted so that it has a more uniform chemistry with minimal voids and contaminants. 304V SS is a flexible, robust material that can easily be soldered or welded. 304V wire is used in many medical applications because of its low cost compared to other materials that meet the minimum standards for corrosion resistance.

WHAT ARE COMMON MATERIALS WE SEE MEDICAL MANUFACTURERS TURNING TO?

Bi-metals are becoming more widely used and popularized. Special alloys and various metals like MP35N, a developmental project-based alloy, offer new, high performance capabilities for surgeons. Other bi-metals like Nitinol with a Platinum core (cladded) and a Nitinol with a Tantalum core have received greater exposure in the medical device marketplace as of late. Heavy metals like Platinum, Tantalum and Tungsten show up extremely well under a fluoroscope during cardiovascular surgery, for example, and allows surgeons to see where they are going within the human body.

Though these other special metal alloys have proven to be great alternatives for the medical industry, 304V stainless steel wire is still most often used in the majority of medical applications because the alloy meets the minimum standards for corrosion resistance while still being a safe and productive material.

WHAT IS CRITICAL TO THE PRODUCTION AND PERFORMANCE OF SURGICAL INSTRUMENTS?

When it comes to surgical instruments, stainless steel alloys—like Austenitics, Martensitics, and PH Grades—that are shaped and designed to perform very specific tasks are critical and common. Alloys used to produce medical instruments should be manufactured to withstand the demands of daily use in healthcare environments, with rigorous attention to detail and quality. From cutting to pricking to stapling, the high-stakes demands of medical devices and surgical instruments require precision manufactured alloys with the exact specifications necessary to perform the job.

ULBRICH IS DRIVING MEDICAL INSTRUMENT INNOVATION THROUGH PRECISION ALLOYS.

With the help of precision special metals, doctors and workers in the medical field can restore and preserve the health of ailing people. At Ulbrich, we take great pride in the fact that our work plays a part—however big or small—in the health of millions. And that's why we're always holding ourselves, our machines, and our processes to the highest of standards. Because with precision alloys, innovative surgical (increasingly robotic) instruments have the power to transform lives.

Different surgical instruments and incision tools require a diverse range of alloys and alloy characteristics. Choosing the best materials and having them produced to exacting mechanical, chemical, and physical specifications ensures that the resulting product, or component delivers more consistency, less waste, and lower failure rates. Ulbrich has a long history of providing alloys and bi-metals to the medical industry due to our strategic sourcing methods, our huge inventory of alloys, and immense rolling and annealing capabilities. It gives us a competitive advantage that we are able to pass on to our customers. So, whether your medical device requires an alloy to be heat-treated to a higher hardness (such as Precipitation Hardening Grades) or something non-magnetic and highly resistant to corrosion (like Austenitic alloys), we're able to make it happen.

SURGICAL INSTRUMENTS MADE WITH PRECISION ALLOYS INCLUDE BUT ARE NOT LIMITED TO:

- Scissors
- Sheers
- Surgical Draws
- Catheters
- Needles
- Lances
- Surgical Grills and Grinders
- Surgical Staplers/Anvils
- Stapler Springs, Staples
- Cardiovascular Clamps
- Tissue Grabbers
- Strip Square
- Surgical Robotic Instruments
- and more...

STAINLESS STEEL:

- 304 Stainless Steel
- 304V Stainless Steel
- 304LV Stainless Steel
- 304LVM Stainless Steel
- 316 Stainless Steel
- 316L Stainless Steel
- 17-4PH Stainless Steel
- 17-7PH Stainless Steel
- 305 Stainless Steel
- 410 Stainless Steel
- 420 Stainless Steel
- 420 High and Low Carbon
- 440A Stainless Steel

SPECIAL METALS:

- Nitinol
- Titanium
- MP35N
- Copper
- Aluminum
- Tungsten
- Beryllium Copper
- Molybdenum
- Phosphor Bronze
- L605
- and many other "bi-metals"

(combinations of cladded wire that may include Silver or Platinum)

304V Stainless Steel Wire UNS S30400

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SHAPED, FLAT, SQUARE, ROUND, FINE WIRE, PLATED AND BARE WIRE ASTM A276, ASTM A313, ASTM A666

304V ALLOY DESCRIPTION

Alloy 304V is a double melted austenitic stainless steel. The alloy is initially electric-arc melted followed by a Vacuum Arc Re-melt (VAR). This melting practice minimizes voids and contaminants while yielding a more uniform chemistry. This refinement to the purity and homogeneity of the metal allows for use in high reliability products.

APPLICATIONS

- Orthodontic arc wire
- Catheters
- Guide wires
- Surgical instruments
- Surgical implant
- Mandrels
- Springs
- Needles

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Get Customized Orders of

304V, 304LVM, or 316LV Stainless Steel Wire for Medical Manufacturing

ULBRICH SPECIALIZES IN TAILORING 304V, 304LVM, AND 316LV WIRE FOR MEDICAL BRAID PRODUCTS AND MEDICAL IMPLANTABLE DEVICES

304V & 304LVM APPLICATIONS

- Surgical Instruments
- Coiled Shafts
- EP Catheters
- Orthodontic Arc Wire
- Braided Catheters
- Micro-Catheters
- Vascular Catheters
- Guide Wires
- Implants
- Stylets
- Needles
- Springs

316LV PRODUCT APPLICATIONS

- Orthopedic Cables
- Skin Closure Staples
- Suture Wire
- Bone Pins
- Catheters
- Implants

STAINLESS STEEL WIRE DELIVERED WITH PRECISION

To better serve our customers' increasing product requirements, we have developed our ***Braid Wire Accelerator® Program***, with product shipping within 24 hours of order acknowledgement. The ability to obtain a variety of round & flat wire quickly allows deadlines to be met while incorporating all the design performance characteristics required of your project. (For more information, see pages 14-15.)

PRECISION WINDING AND SHAPING OF ALL WIRE PRODUCTS

We offer precision winding of a variety of round, flat and shaped wire products. Our "focus factory" (factory within a factory) dedicates managers and engineers along with state of the art equipment to produce and manage industry specific requirements. Ulbrich's technical support staff also assists with any customer to provide the needed application specific guidance.

MEDICAL WIRE CONSISTENCY AND INCREASED PERFORMANCE

The expansion of our in-house drawing and plating capabilities has led to industry expertise in bare and plated mandrels and stylets for medical applications. Focusing on SPC and Bare Precision Copper Mandrel Materials, Ulbrich's metallurgical prowess allows us to offer multiple custom tempers and finishes in quantities ranging from small R&D lots up to full production runs.

Haynes® 25 L-605 Wire UNS R30605

SHAPED, FLAT, SQUARE, ROUND, FINE WIRE, PLATED AND BARE WIRE ASTM F90, AMS 5537, AMS 5759, AMS 5796, AMS 5797, AMS 5976

We Deliver Precision®

L-605 ALLOY OR HAYNES® 25 WIRE DESCRIPTION

L-605 is a cobalt based alloy resistant to oxidation and carburization to 1900°F and has good forming and excellent high temperature properties. L-605 can only be hardened significantly by cold working. Cold working will increase creep strength up to 1800°F and stress rupture strength up to 1500°F. Strain aging at 700-1100°F improve creep and stress rupture strengths below 1300°F.

APPLICATIONS

- Seal rings for gas turbines
- High temperature ball bearings and races
- Jet engine components
- Springs

MP35N® UNS R30035

STRIP, COIL, FOIL & WIRE, AMS 5758, AMS 5844, AMS 5845, ASTM F562

MP35N® DESCRIPTION

MP35N® is an age hardenable Nickel-Cobalt base superalloy that has a unique combination of properties - ultra high strength, toughness, ductility and outstanding corrosion resistance. MP35N® resists corrosion in hydrogen sulfide, salt water and other chloride solutions. It also has excellent resistance to crevice and stress corrosion cracking in sea water and other hostile environments. Suitable where a high combination of strength, high modulus values and good corrosion resistance are required.

APPLICATIONS

- Fasteners
- Springs
- Seawater
- Oil and gas well
- Medical and dental devices/instruments
- Nonmagnetic electrical components
- Food processing environments
- Chemical applications

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Nitinol Wire

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SHAPED, FLAT, SQUARE, ROUND, FINE WIRE, BLACK OXIDE, LIGHT OXIDES AND OXIDE FREE NITINOL WIRE ASTM F2063 (CHEMISTRY)

NITINOL DESCRIPTION

Nitinol is a nickel-titanium alloy with super elasticity and shape memory properties. Shape memory refers to the ability of Nitinol to undergo deformation at one temperature, then recover its original, under formed shape upon heating above its transformation temperature. Super elasticity occurs at a narrow temperature range just above its transformation temperature; in this case, no heating is necessary to cause the under formed shape to recover, and the material exhibits enormous elasticity, some 10-30 times that of ordinary metal.

APPLICATIONS

- Medical Devices: Stents, Catheters, Heart Valve Tools, Staples, Bone Anchors
- Aerospace Heat Engine Components
- Temperature Control System and High Reliability Couplings
- Resilient Glass Frames
- Orthodontic Arc Wires
- Actuators

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CAPABILITY SHEET

Fine Nitinol: Flat & Round Wire

BASE MATERIAL		ASPECT RATIO	
Standard Binary per ASTM F2063 (NiTi 1)	Chrome Doped	Minimum	Maximum
		2:1	40:1

Dimensions & Size Tolerances *(Standard tolerances - please ask for your custom requirement)*

FLAT WIRE

	NOMINAL VALUE		TOLERANCE	
	Minimum	Maximum	Minimum	Maximum
THICKNESS	0.0003” [inch]	0.015” [inch]	+/- 0.0001” [inch]	+/- 0.001” [inch]
WIDTH	0.0015” [inch]	0.150” [inch]	+/- 0.0002” [inch]	+/- 0.005” [inch]

ROUND WIRE

	NOMINAL VALUE		TOLERANCE	
	Minimum	Maximum	0.0020” and under	+/- 0.00010” [inch]
DIAMETER	0.0007” [inch]	0.025” [inch]	0.0021” to 0.0050”	+/- 0.00015” [inch]
			0.0051” and above	+/- 0.00020” [inch]

Typical Mechanical Properties of Nitinol *(Size dependent)*

	TYPICAL AS DRAWN (AD)		TYPICAL STRAIGHT ANNEALED (SE)	
	UTS (ksi)	Elongation (%)	UTS (ksi)	Elongation (%)
NITI 1	200 Min	4% Min	180 Min	10% Min
CHROME DOPED	210 Min	4% Min	180 Min	10% Min

Packaging *(Our machinery can adapt to most custom spools upon request)*

SPOOL TYPE	DIMENSIONS
30mm Steeger	1.57” flange x 1.40” width x 1.18” barrel x 0.42” bore
26mm Steeger	1.69” flange x 1.40” width x 1.02” barrel x 0.42” bore
15mm Steeger	1.57” flange x 1.40” width x 0.59” barrel x 0.42” bore
Wardwell	2.60” flange x 3.25” width x 0.74” barrel x 0.657” bore
DIN 100	3.94” flange x 2.52” width x 2.48” barrel x 0.63” bore
DIN 125	4.92” flange x 4.92” width x 3.15” barrel x 0.63” bore
Bulk Spools	Various

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CAPABILITY SHEET

Medical Mandrel Wire for Catheter Production

SILVER PLATED (SPC) AND BARE COPPER WIRE PROVIDES FLAKE FREE MEDICAL MANDREL WIRE

Silver plated and bare precision drawn copper mandrel material is critical for producing exacting catheter manufacturing applications. With the addition of silver plated and bare copper wire to the company's expanding line of materials, Ulbrich Specialty Wire Products continues to strive to be the one medical alloy supplier for the demanding needs of all medical manufacturers.

Typical Properties of this New Silver Plated Material:

- Elongations of 25% minimum
- Plating thicknesses of 1.25% and 2%
- Custom plating thicknesses, diameters and tempers
- A full spectrum of final diameters are available

ISO Certified Company In-House Capabilities:

- Plating
- Drawing
- Annealing

ISO 9001: 2015 CERTIFIED

Spooling & Packaging Options as Standard:

- 22" Reel (400 lbs max) diameters above 0.020"
- D-50 (50 lbs max) diameters above 0.010" to 0.025"
- D-25 (25 lbs max) diameters up to 0.030"

Note: These are standard tolerances and spooling options. Please contact sales for custom tolerances and packaging. Ulbrich will conform to customer requirements as needed.

Diameter Range	Tolerance
0.0200" and below:	+/– 0.0002"
0.0201" — 0.0399":	+/– 0.0004"
0.0400" — 0.0599":	+/– 0.0005"
0.0600" — 0.0799":	+/– 0.0005"
0.0800" and above:	+/– 1% DIA

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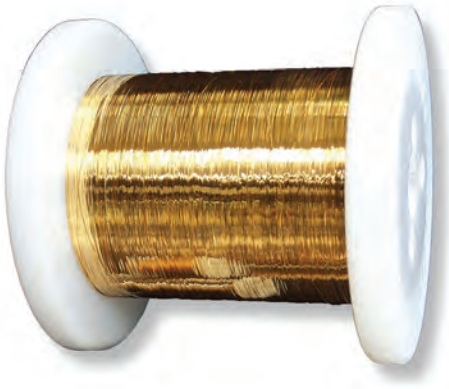
CAPABILITY SHEET

Gold Plated Tungsten
Fine Wire for Medical Devices



Ulbrich is pleased to offer gold plated tungsten fine wire as a replacement for your platinum & platinum alloy applications. Gold plated tungsten offers the following material advantages:

✓ **Lower Cost**

Depending on current commodity pricing, you can expect to spend 1/3 to 1/5 less versus the price of traditional platinum and platinum alloys.

✓ **The Same Ease of Assembly**

Gold plated tungsten solders securely to your current mandrel materials.

✓ **Higher Strength Assemblies**

Tungsten's 400+ ksi tensile strength is much higher than that of a platinum and its alloys.

✓ **Variable Gold Plating Thickness Available**

Ulbrich can apply a thin layer to improve coiling on your current equipment or a thicker layer to improve radiopacity in the most distal locations. We are happy to work with your technical people to insure you only pay for the amount of gold you need.

Gold plated tungsten wire can also be wound on braiding bobbins to make your braided components more visible as well. The higher tensile property allows braiding with stainless materials without the breaks you might encounter from lower strength platinum materials.

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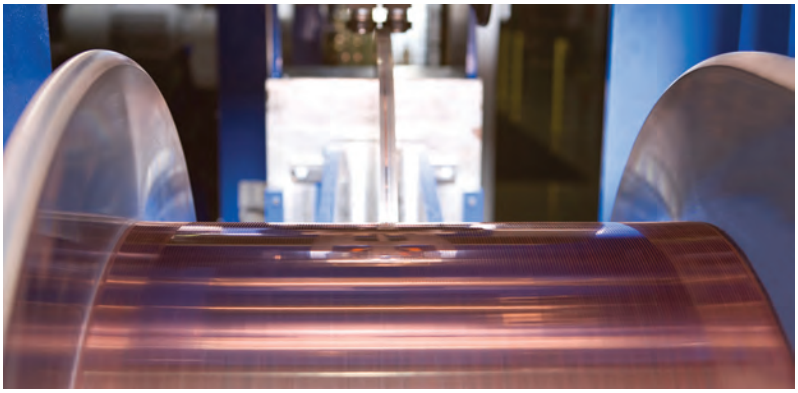
PLATED PRODUCTS

Metals for Medical



CUSTOM PRECISION PLATING

Specialized in the continuous plating of fine, round and flat wire, Ulbrich has in-house plating equipment for your custom medical device requirements.

WE CAN PLATE ALMOST ANY ALLOY WITH:

- Gold
- Silver
- Nickel
- Tin
- Tin/Lead Solders
- Tin/Silver

BASE MATERIALS

STAINLESS STEELS

- 304
- 304V
- 304L
- 304LV
- 304LVM
- 316
- 316L
- 316LVM

SPECIALTY METALS

- Copper
- MP35N
- Copper Clad Steel & Aluminum
- Tungsten
- Phos/Bronze
- Copper Beryllium

APPLICATIONS

- Copper and Silver-Plated Copper Mandrels for Catheter Applications
- Reinforced Catheters
- Electronic Devices
- Leads and Connectors
- Guidewires
- Tubing Mandrels
- Embedded Wire
- Orthodontia
- Braiding
- Coils

SPECIAL SERVICES AVAILABLE

- Precision Spooling
- Customized Processes

(Precision size tolerances for all round and flat wire are available per your specific requirements.)

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DEVELOPMENT PARTNERSHIP

Braid Wire **Accelerator®** PROGRAM

At Ulbrich, we understand medical device development timelines continue to be reduced. The need for device designers to iterate quickly is accelerating and rarely supported by the supply chain. To better serve our customers' ever increasing requirements, we have developed our fine wire stocking program.

- We provide you the ability to obtain a variety of round and flat wire quickly
- This program can have wire in your hands in 72 hours or less
- Product ships within 24 hours of order acknowledgement
- Your project teams are now able to meet their timelines while incorporating all the design performance characteristics your devices require
- Need minor modifications? Ask about our semi-finished-materials program!

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Material	Size	Tensile Range	Winding Tension	Bobbin Type	Feet/Bobbin	Part Number
304V	.0005” x .0025”	300-355 ksi	50 grams	Steeger 30mm	5,000	7894-7012
304V	.0005” x .003”	300 ksi min	60 grams	Steeger 30mm	5,000	7894-7011
304V	.0007” x .003”	300 ksi min	50 grams	Steeger 30mm	5,000	7894-7014
304V	.001” x .003”	150-180 ksi	50 grams	Steeger 30mm	5,000	7894-7000
304V	.001” x .003”	200-250 ksi	50 grams	Steeger 30mm	5,000	7894-7002
304V	.001” x .003”	300-355 ksi	50 grams	Steeger 30mm	5,000	7894-7001
304V	.001” x .003”	High Tensile 400 ksi min	75 grams	Steeger 30mm	5,000	7894-7024
304V	.001” x .005”	150-200 ksi	75 grams	Steeger 30mm	5,000	7894-7003
304V	.001” x .005”	200-250 ksi	50 grams	Steeger 30mm	5,000	7894-7004
304V	.001” x .005”	300 ksi min	75 grams	Steeger 30mm	5,000	7894-7005
304V	.002” x .005”	300 ksi min	85 grams	Steeger 30mm	2,500	7894-7016
304V	.002” x .006”	300 ksi min	100 grams	Steeger 30mm	2,500	7894-7015
304V	.0015” x .005”	300 ksi min	75 grams	Steeger 30mm	5,000	7894-7023
304V	.0005” x .0015”	300 ksi min	60 grams	Steeger 30mm	5,000	7894-7041
304V	.0015” Rd	300 ksi min	75 grams	Steeger 30mm	5,000	7894-7038
304V	.00075” Rd	300 ksi min	25 grams	Steeger 30mm	5,000	7894-7022
304V	.001” Rd	235-265 ksi	25 grams	Steeger 30mm	5,000	7894-7006
304V	.001” Rd	300 ksi min	40 grams	Steeger 30mm	5,000	7894-7007
304V	.001” Rd	High Tensile 425 ksi min	25 grams	Steeger 30mm	5,000	7894-7026
304V	.0015” Rd	235-265 ksi	50 grams	Steeger 30mm	5,000	7894-7013
304V	.002” Rd	151-200 ksi	50 grams	Steeger 30mm	5,000	7894-7008
304V	.002” Rd	235-265 ksi	50 grams	Steeger 30mm	5,000	7894-7009
304V	.0005” Rd	300 ksi min	15 grams	Steeger 30mm	5,000	7894-7025
304V	.002” Rd	300 ksi min	50 grams	Steeger 30mm	5,000	7894-7010
304V	.002” Rd	High Tensile 425 ksi min	75 grams	Steeger 30mm	5,000	7894-7027
304V	.002” Dual-lead	300 ksi min	50 grams	Steeger 30mm	5,000	7894-7021
304V	.002” 3 ends	300 ksi min	50 grams	Steeger 30mm	4,200	7894-7028
304V	.002” 4 ends	300 ksi min	50 grams	Steeger 30mm	4,000	7894-7029
304V	.003” Rd	300 ksi min	100 grams	Steeger 30mm	4,000	7894-7017
Nitinol	.001” Rd	As Drawn, Oxide Finish	30 grams	DIN 100	2,500	7990-7100
Nitinol	.001” Rd	As Drawn, Oxide Finish	35 grams	Steeger 30mm	1,000	7990-7101
Nitinol	.002” Rd	As Drawn, Oxide Finish	60 grams	DIN 100	2,500	7990-7102
Nitinol	.002” Rd	As Drawn, Oxide Finish	60 grams	Steeger 30mm	1,000	7990-7103
Nitinol	.003” Rd	As Drawn, Oxide Finish	60 grams	DIN 100	2,500	7990-7104
Nitinol	.003” Rd	As Drawn, Oxide Finish	85 grams	Steeger 30mm	1,000	7990-7105
Tungsten	.001” x .003”	400 ksi min	75 grams	Steeger 30mm	500	7894-7042
Tungsten	.0005” x .0015”	400 ksi min	75 grams	Steeger 30mm	500	7894-7043
Tungsten	.0005” x .003”	400 ksi min	75 grams	Steeger 30mm	500	7894-7044
Tungsten	.0005” Rd	450 ksi min	40 grams	Steeger 30mm	1,000	7894-7039
Tungsten	.0007” Rd	450 ksi min	75 grams	Steeger 30mm	1,000	7894-7040
Tungsten	.001” Rd	400 ksi min	75 grams	Steeger 30mm	2,500	7894-7030
Tungsten	.002” Rd	400 ksi min	75 grams	Steeger 30mm	2,500	7894-7031
L605	.002” Rd	300 ksi min	75 grams	Steeger 30mm	2,500	7894-7032
L605	.001” x .003”	300 ksi min	75 grams	Steeger 30mm	2,500	7894-7033
CuBe 172	.002” Rd	185-245 ksi	75 grams	Steeger 30mm	2,500	7894-7034
CuBe 172	.001” x .003”	185-245 ksi	75 grams	Steeger 30mm	2,500	7894-7035
MP35N	.002” Rd	300 ksi min	75 grams	Steeger 30mm	2,500	7894-7036
MP35N	.001” x .003”	300 ksi min	75 grams	Steeger 30mm	2,500	7894-7037

ULBRICH STAINLESS STEEL ROUND & FLAT BRAID WIRE CAPABILITY SHEET

BASE MATERIAL	Primary	Custom Alloys		
	304V Stainless Steel	304L	316	316L
		Nitinol	MP35N	L605

ASPECT RATIO	MINIMUM THICKNESS	MAXIMUM THICKNESS
	2:1 @ 0.0010” [inch]	10:1 @ 0.0025” [inch]

Dimensions & Size Tolerances *(Standard tolerances - please ask for your custom requirement)*

FLAT WIRE

	NOMINAL VALUE		TOLERANCE	
	Minimum	Maximum	Minimum	Maximum
THICKNESS	0.0002” [inch]	0.0060” [inch]	+/- 0.0001” [inch]	+/- 0.0006” [inch]
WIDTH	0.0020” [inch]	0.0200” [inch]	+/- 0.0002” [inch]	+/- 0.0020” [inch]

ROUND WIRE

	NOMINAL VALUE		TOLERANCE	
	Minimum	Maximum	0.0030” and under	+/- 0.00005” [inch]
DIAMETER	0.0007” [inch]	0.0100” [inch]	0.0031” to 0.0050”	+/- 0.00007” [inch]
			0.0051” and above	+/- 0.0001” [inch]

TEMPER (304V)	TENSILE RANGE
Spring Temper	300,000 [psi] - 355,000 [psi]
3/4 Hard	250,000 [psi] - 300,000 [psi]
1/2 Hard	200,000 [psi] - 250,000 [psi]
1/4 Hard	150,000 [psi] - 200,000 [psi]
Annealed	100,000 [psi] - 150,000 [psi]
Custom Tempers	Available on request - as high as 460,000 [psi]

Packaging *(Our machinery can adapt to most custom spools upon request)*

SPOOL TYPE	DIMENSIONS
30mm Steeger	1.57” flange x 1.40” width x 1.18” barrel x 0.42” bore
26mm Steeger	1.69” flange x 1.40” width x 1.02” barrel x 0.42” bore
15mm Steeger	1.57” flange x 1.40” width x 0.59” barrel x 0.42” bore
Wardwell	2.60” flange x 3.25” width x 0.74” barrel x 0.657” bore
NEB	1.32” flange x 3.95” width x 1.37” barrel x 0.33” bore
DIN 100	3.94” flange x 2.52” width x 2.48” barrel x 0.63” bore
DIN 125	4.92” flange x 4.92” width x 3.15” barrel x 0.63” bore
Bulk Spools	Various

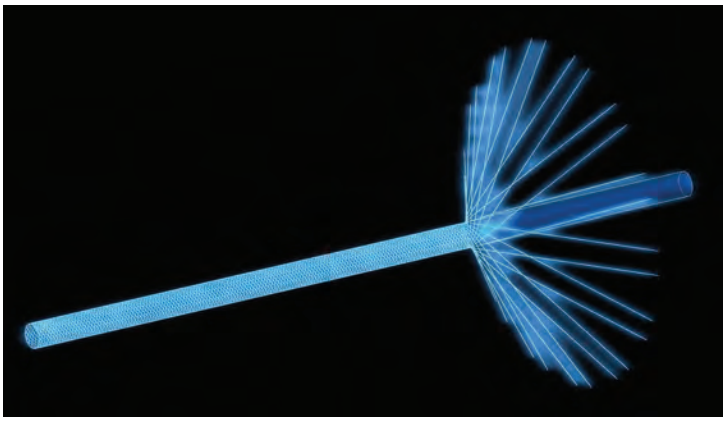
Braid-Reinforced Medical Tubing

THE WIRE PRODUCER'S ROLE IN ENABLING OPTIMAL BRAIDING PERFORMANCE

Medical tubing is an essential component in an ever-expanding array of delivery systems and related devices used in minimally invasive surgical procedures. Round or flat stainless steel wire is often used to braid-reinforce tubing for applications that require torque transmission, burst strength, or column strength. The tubing material and wire specifications, along with the braiding PIC count, are collectively used to achieve the desired level of stiffness, torque response, & related characteristics of the tubing.

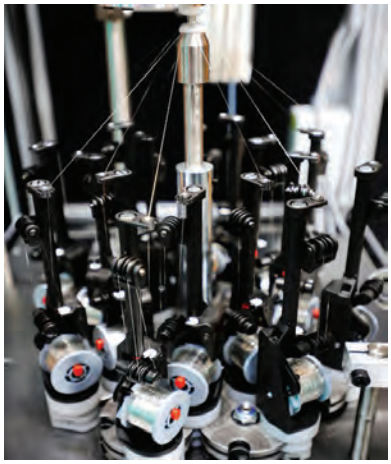
Producing ultra-fine wires to extremely small dimensions that can be less than 15% the size of a human hair is only the beginning. Precisely controlling the dimensions, mechanical properties, and cleanliness over the length of the wire is essential. The science, know-how, and practices required to enable optimal performance in the subsequent braiding operation is a topic unto itself. It will be the primary area of focus for this article.

The braiding process requires that wires be wound onto braider bobbins, which are then placed into carriers on the braiding machine. 16 - 32 carrier braiding machines are commonly used in medical tubing applications, though up to 288 carriers can be used in some instances. The wire on every bobbin must unroll smoothly and consistently if the braiding process is to produce suitable braid-reinforced medical tubing.



Some problems encountered in braiding that can be attributable to the wire include:

- Tangles
- Breaks
- Kinks
- Twists
- Contamination



AVOID THE BREAKS! WINDING WIRE ONTO BRAIDER BOBBINS TO ENABLE OPTIMAL BRAIDING PERFORMANCE.

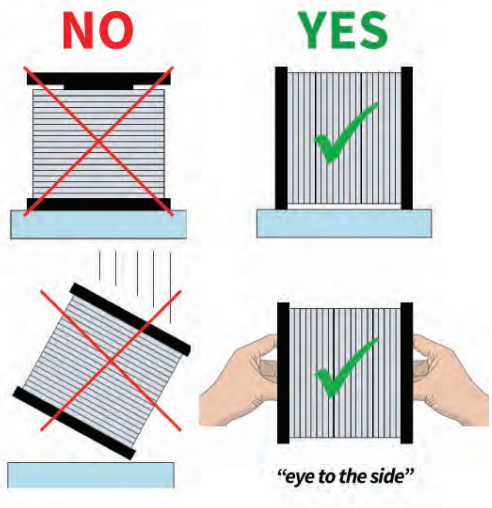
Ensuring accuracy in the dimensions of the bobbins and winding device, and precise concentricity and alignment are only the first steps. The wire must be wound with an array of parameters that should be matched to the parameters that will be used in the braiding process itself. A "level wind" can only be achieved if the traverse dimensions, spacing, and reversal settings are appropriately set & controlled. If the wire is not level from flange to flange, it will likely lead to problems during braiding.

Biconical bobbins are sometimes used to make it easier to wind and unwind the wires, but straight-flanged bobbins will perform well if the winding is controlled correctly. Moreover, the winding tension should be selected based upon the tension that will be used during braiding. Typically, braiding machines use special ratchet and tension springs to set and maintain the tension. The wire should be wound with slightly higher tension than the braiding tension. Optimum performance can only be achieved if the wire manufacturer & the braid wire manufacturer work together to define the unique winding parameters for each bobbin to be wound, ultimately based upon braiding parameters used.

PREVENTING TANGLES AND BREAKS IN THE BRAIDING PROCESS

Wire tangles and breaks can be caused by many possible factors in the braiding process and are not always attributable to the wire itself or the winding parameters used to wind it onto the bobbin. However, there are several factors directly related to the wire that can result in tangles and/or breaks.

For example, if there is a gap between the flange and the layers of wire at one end of the bobbin barrel or the other, the wire can "snag" in the gap as it is unwinding. This will most often result in a wire break. Wire manufacturers must ensure an even and precise wind that eliminates this gap to ensure quality and prevent snagging as the bobbin contents unwind during the braiding process.



Another common cause of tangles or breaks is when the wind is not level across the length of the barrel; adjacent wraps of wire can slide over or under one another as they are unwound. This results in a tangle and often a wire break. This can also happen if the wire bobbin is stored or mishandled, which is why braid wire manufacturers must ensure that their teams are well trained in proper wire handling to prevent a pristine bobbin from being jeopardized due to user error.

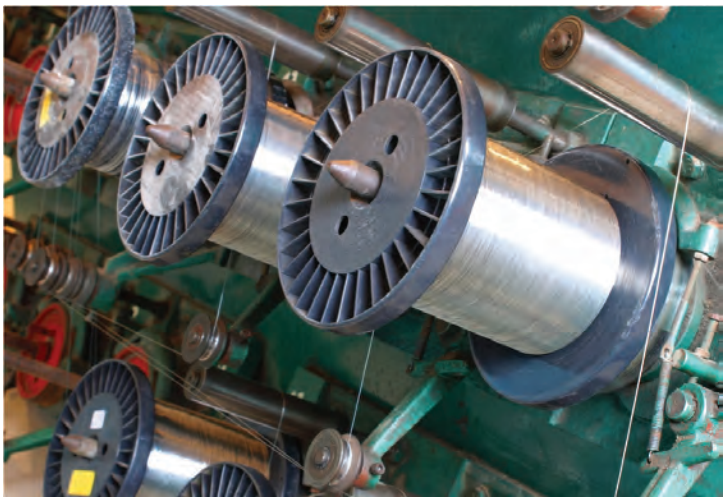
When the tension used to wind the wire onto the bobbin is less than the tension applied in the braiding process, the wire can be pulled into the gaps in the layers below as it is paying off. This is another wire production factor that can cause a tangle or break.

Flat wires in a certain width to thickness (aspect) ratio range can be more prone to tangling or breaking due to the intricacies of their geometries coupled with the winding and braiding processes themselves. This challenge can be effectively addressed with the controlled application of an approved lubricant such as isoparaffinic mineral oil. This method of preventing tangling is widely used within the wire manufacturing industry. It can prevent a great deal of scrap loss and downtime caused by tangling in the precision wire that falls within these aspect ratios.

Wire tangles and breaks result in a stoppage of the braiding process, which results in scrap and time lost restarting the process. It is a problem that all braiders will strive to minimize or eliminate.

PREVENTION WITH A MILD ISOPARAFFINIC LUBRICANT SUCH AS ISOPAR®

As we mentioned, flat wires within a specific range of aspect ratios tend to be more problematic to braid. The challenges with this category of wires can be overcome by applying a very light, carefully controlled coating of IsoPar®. This mineral oil is used in a variety of personal care products where it comes in contact with the human body. IsoPar® is an isoparaffin that has proven safe in biotoxicity testing and can be beneficial in enabling improved braiding performance for more troublesome wire aspect ratios. It can also help prevent wire shavings that can result from metal to metal contact during the braiding process if the wire is "too clean".



AVOIDING KINKS AND TWISTS

Kink resistance is an essential aspect of a braided medical wire, so it is critical for manufacturers to ensure that the braiding process and the wire being used are set up correctly during the production process to prevent them. If an incorrect or inconsistent wire gap setting is used in the bobbin winding process, the wires may not pay off evenly, resulting in potential twists or kinks.

Twists and kinks do not entirely stop the braiding process but will result in a defective product that is not always easy to detect in the tubing. Preventing these defects from occurring is essential for quality control and scrap reduction. Carefully matched and controlled winding parameters, coupled with the selective use of IsoPar® on specific wire sizes, can conquer many of the common root causes of kinks and twists.

In addition to uneven or mismatched wires being used on braiding machines, many of the factors noted above that cause tangles and breaks can also result in twists or kinks, particularly uneven wind, tension mismatch, and problematic aspect ratio wires that are unlubricated.

It's vital to mutual success, and downstream quality assurance that medical manufacturers and their wire producers work closely together to define critical parameters, specifications, and machine and production settings to ensure that the materials used can achieve the high performance demanded of them.

Ulbrich is a constant partner to our customers in developing and delivering high-quality fine and flat wire materials that are kink-resistant and optimized to our customers' unique demands.

CONTAMINATION

Contamination can originate from several potential sources. The most common is loose debris introduced onto the tubing, wire or braiding equipment, and substances carried by the tubing or wire itself. Focusing upon what should be done from the wire perspective to prevent contamination, it should be packaged and protected appropriately to avoid loose debris from being introduced during handling and shipping. Potential contaminants that could be carried into the process by the wire can be managed by adequately controlling the wire processing environment & using cleaning processes that are effective in removing residual compounds that are used in upstream cold working processes.

CONCLUSION

Ulbrich possesses a wealth of knowledge and experience in providing braiding wires that perform effectively & consistently in the braiding processes used to produce braid-reinforced medical tubing. Matching winding parameters with the parameters that will be used in the braiding process is essential in optimizing braiding performance. This can only be achieved if our customer shares their braiding process information with us, enabling us to specify the proper winding parameters for that unique wire item number. Collaborative discussions typically result in practical solutions for these and other challenges related to the design and production of high-quality braid-reinforced medical tubing.

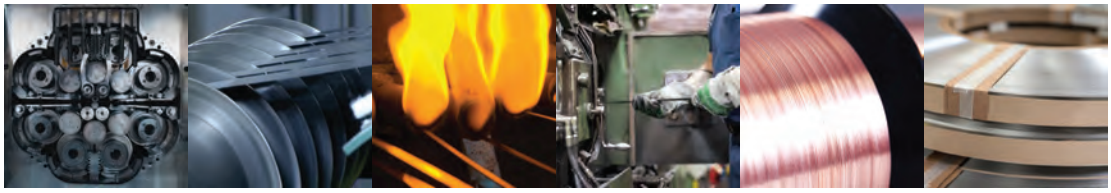
If you are a producer of braid-reinforced medical tubing and have questions or are looking to collaborate on challenges you're looking to overcome, feel free to reach out to us. We'll be happy to connect you with one of our metallurgical engineering experts!

We Deliver Precision®

ULBRICH.COM

Our Industry Leading Capabilities

DESIGNED WITH YOUR SUCCESS IN MIND



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.

Precision Products & Alloys for Medical

WE'RE ALWAYS LOOKING FOR WAYS TO INNOVATE AND IMPROVE UPON MEDICAL DEVICES

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 medical device 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 steels and special metals to the Medical Device Industry. During this time, we have participated in the development and manufacturing of hundreds of innovative medical applications. With industry leading Dimensional Control, real time gauging and Statistical Process Control (SPC), a large variety of medical 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 metals products to satisfy the needs of the medical devices original equipment manufacturers.

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**

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