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# METAL FINISHING FOR THE DENTAL INDUSTRY

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# INTRODUCTION

*Improving Sanitation, Cleaning and Performance*

Superior sanitation, enhanced corrosion resistance and a bright and decorative finish are just a few of the many benefits the dental industry enjoys from electropolishing. Whether it's performing routine dental care, periodontal procedures or orthodontic procedures, the dental industry requires highly sanitary instruments that can sustain stringent sanitation treatments time and time again.

Moreover, because these tools come in contact with living tissue in patients' mouths, biocompatibility is critical. Improperly finished instruments such as those with surface burrs can also pose a biohazard risk to patients as metal flecks can chip or flake off during use.



Because many of these instruments are highly visible to patients, their visual appearance is also paramount. A bright and decorative finish signals a sanitary finish that ensures confidence in patients.

For these reasons, dental instruments require a finish process that:

- increases corrosion resistance
- removes surface burrs
- offers fatigue life improvement
- enhances microfinish
- creates an easy-to-clean, sanitary surface
- provides a bright and decorative finish
- promotes optimal part function and performance

In addition to all of these requirements, dental tools pose a special challenge to engineers when it comes to finishing due to the small size, and often fragile, nature of the components. Because of this, many traditional finishing methods such as grinding, blasting, vibratory finishing or mechanical polishing fail and can actually damage and compromise part integrity. In these cases, electropolishing is especially favorable and more cost effective as it can be used to treat parts with a complex geometry or small size.

Thanks to the ability to tightly control the amount of material removed during the process, from as low as .0002" up to .003", electropolishing provides repeatable results from part to part and job to job. Repeatability and precision make electropolishing a smart choice for finishing a variety of tools and instruments used for dental applications.

Unlike other finishing methods, electropolishing can achieve all of these benefits in one single operation, efficiently reducing time to market and overall cost-effectiveness during manufacturing.





# TECHNICAL SUMMARY

Electropolishing is often referred to as a “reverse plating” process. Electrochemical in nature, electropolishing uses a combination of rectified current and a blended chemical electrolyte bath to remove flaws from the surface of a metal part.

*The dental tool industry relies on electropolishing for its many benefits including improved cleaning operations, extended corrosion resistance, burr removal and more.*

Since the development of electropolishing in the 1950s, substantial refinements have taken place. Able has numerous electrolytes to allow for electropolishing on a broad range of metals. These newer electrolytes, combined with advanced part handling techniques, have improved production yields on a wide range of metal products.

Following treatment, metal parts have improved microfinish value, an ultraclean surface, and enhanced corrosion resistance.

## ALLOYS WE ELECTROPOLISH

Able specializes in providing electropolishing services for a variety of common and specialty metal alloys. Here is a partial list of alloys we can electropolish:

- 200-300 Series Stainless Steels
- 400 Series Stainless Steels
- Precipitating Hardening Grades
- Unusual Stainless Steels
- Copper Alloys
- Tool Steels
- Aluminum
- Titanium
- Nitinol
- Specialty Alloys
- Nickel Alloys
- Specialty Steels
- Carbon Steels

## WHAT IT DOES

While electropolishing is best known for the bright polish left on a surface, there are some important, often overlooked, benefits of this metal finishing method. These benefits include deburring, size control, microfinish improvement, ultraclean finishing, corrosion resistance, and others. These metal improvement benefits are highly desirable to design and production engineers for cost savings and product lifespan improvement.

## HOW IT WORKS

The typical electropolishing installation is deceptively similar to a plating line. A power source converts AC current to DC at low voltages. A rubber-lined tank, usually fabricated from steel, is used to hold the chemical bath.

A series of copper or stainless steel cathode plates are lowered into the bath and installed to the negative (-) side of the power source. A part or group of parts is fixed to a rack made of titanium, copper or bronze. That rack in turn is fixed to the positive (+) side of the power source. As the adjoining illustration depicts, the metal part is charged positive (anodic) and immersed into the chemical bath.

When current is applied, the electrolyte acts as a conductor to allow metal ions to be removed from the part. While the ions are drawn toward the cathode, the electrolyte maintains the dissolved metals in solution. Gassing in the form of oxygen occurs at the metal surface, furthering the cleansing process.

Once the process is completed, the part is run through a series of rinsing and drying steps to remove clinging electrolyte. The resulting surface is ultraclean and bright. In fact, the bright surface is the most identifiable trait and is what helped coin the process name: electropolishing.

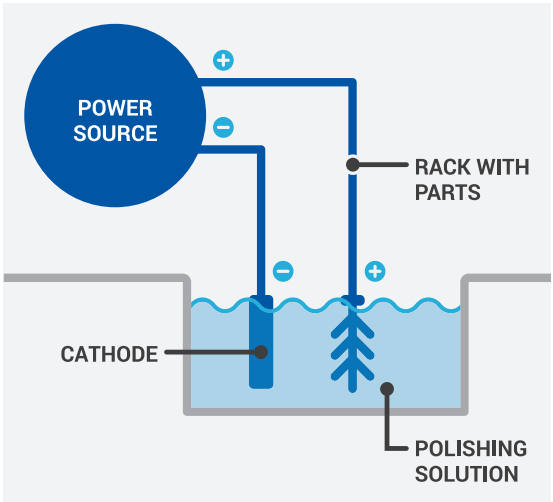


Figure 1

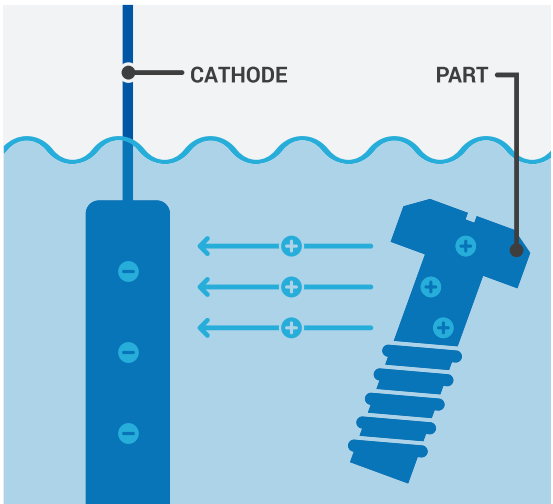


Figure 2

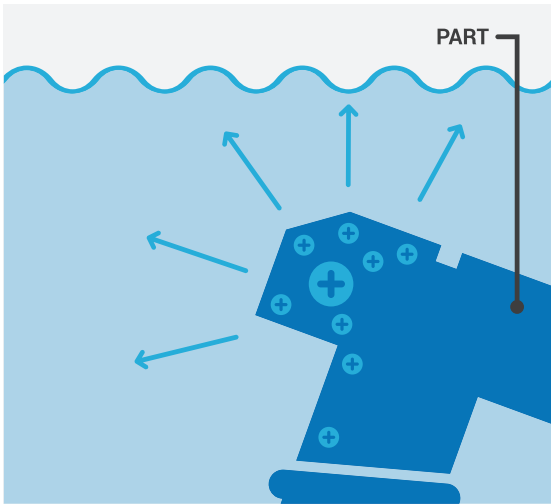


Figure 3

# CORROSION RESISTANCE

One of the most valuable benefits of electropolishing in the dental tool industry is enhanced resistance to corrosion. Many dental instruments, including drills, autoclave cassettes, and endodontic instruments undergo stringent cleaning operations to ensure cleanliness and proper removal of bacteria. To achieve optimal sanitation, instruments are often subjected to repeated autoclave cleaning, which places them in a highly corrosive environment.

Corrosion on dental instruments can be detrimental to overall performance and cycle life. Most importantly, corrosion can put patients at risk of infections and compromise effectiveness of treatments.

Electropolishing dental instruments electrochemically removes the amorphous layer that is created on the surface of a part during machining, stamping, grinding, vibratory tumbling or other secondary operations. Unlike mechanical polishing, electropolishing effectively removes the free iron, lubricants and other contaminants that become embedded in the surface metal’s pores during machining while improving corrosion resistance. Left in the metal, these contaminants can become initiation sites for corrosion.

*Electropolishing metal instruments can efficiently enhance corrosion resistance for more sanitary and safe instruments.*

While electropolishing is most often used to inhibit corrosion on stainless steel, it is also highly effective in delaying or hindering the occurrence of oxidation on Nitinol titanium, aluminum, copper, brass, carbon steel and other alloys.

## COMMONLY ELECTROPOLISHED PARTS

- Dental drills
- Dental handles
- Autoclave cassettes
- Endodontic instruments
- X-ray components

## CASE STUDY: ELECTROPOLISHING NITINOL FOR THE DENTAL/ORTHODONTIC INDUSTRY

In recent times, Nitinol has been a choice material for engineers in the Dental & Orthodontic fields. Not only are the physical and mechanical properties favorable to creating functional implants and devices but this material can be made biocompatible when electropolished. In addition, electropolishing decreases surface roughness. By smoothing out surface irregularities, electropolishing can both extend the fatigue life of parts as well as eliminate nooks and crannies for bacteria to harbor. In the case of Nitinol rotary endodontic instruments, fatigue testing has been performed showing electropolished instruments last significantly longer than non-electropolished instruments. Based on the current density of the microscopic high points vs the low points of a given surface, electropolishing provides a surface leveling effect thus greatly reducing initiation sites for fracture.

Without proper surface treatment, metal that has been cut, heated, formed, ground, etc. is susceptible to corrosion because the protective passive layer is altered and damaged.

There is much evidence that electropolishing increases the corrosion resistance of many metal alloys, including Nitinol. In the case of Nitinol orthodontic arch wires, electropolishing improves corrosion resistance both making the wire more robust and reducing toxicity exposure to the patient. This is due to the way in which the electro-chemical reaction of the electropolishing process enriches, stabilizes and strengthens the titanium dioxide protective (passive) layer on the surface of the metal component.

Able provides both passivation and electropolishing services for Nitinol dental & orthodontic components per industry standard ASTM F86, electropolishing is typically the preferred method due to the fact that electropolishing not only creates a passive layer, but also provides a smoother surface thus creating a more uniform and stronger titanium oxide layer that will resist corrosion longer. Furthermore, electropolishing, unlike passivation, removes a skin of metal from the surface thus removing imbedded contaminants and micro burrs from the manufacturing process.



# DEBURRING

Burrs can develop during many types of manufacturing processes including grinding, machining, stamping and cutting. Manufacturers of dental and endodontic instruments turn to electropolishing as a reliable method for removing burrs from components such as high-speed drills, extractors and other oral surgical tools.

Burrs on instruments used in dental or orthodontic procedures can directly impact the function of these devices and can even lead to premature failure. Burrs on cutting edges, for example, can reduce ease and rate of cutting. Eliminating imperfections from moving parts like those found in drills can also extend their life cycle.

Biohazard risks to patients are also possible when burrs are present on the surface of dental instruments as they may flake or chip off during use.

Electropolishing effectively removes burrs from even the most fragile and complex parts to improve overall surface finish and part performance. It removes flecks of metal and contaminants that may be present from machining or manufacturing, creating a smooth finish without creating distortion or warping. The resulting finish is an ultra-smooth surface free of burrs.

*Electropolishing is the most effective solution for deburring without creating distortion or warping for optimal part integrity.*

Electropolishing is especially well suited for parts having fine blanking, milling, broaching, lapping or grinding burrs. Because the process can be performed on nearly any alloy, it's often preferred as a final deburring and finishing process across many industries.

### COMMONLY ELECTROPOLISHED PARTS

- Drill bits





# FATIGUE LIFE IMPROVEMENT

Improving cycle life and part longevity is critical for any manufacturer. In the dental industry, this is especially true for parts that cycle such as those found in dental drills and high-speed rotary cutting instruments.

Electropolishing is a popular metal finishing process used to help improve the life of metal parts. During the electropolishing process, the removal of a uniform layer of surface material from the entire part strips away surface imperfections and micro-cracks that can threaten a part’s performance. These defects, often in the form of micro-cracks or pits, can become initiation sites for crack propagation or corrosion. By removing micro defects from the surface of components, electropolishing effectively prolongs the life of parts.

Increased corrosion resistance resulting from electropolishing also helps extend the life of dental instruments, especially those that undergo repeated sterilization.

*By removing micro-defects from the surface, electropolishing helps improve the longevity of components.*

Electropolishing’s unique process reduces the development of cracks and fissures that often lead to premature part failure. The defect-free surface that results after electropolishing improves overall life longevity.

## COMMONLY ELECTROPOLISHED PARTS

- Files



# MICROFINISHING

The proper microfinish is crucial in assemblies where contact to metal surfaces occurs. When small parts, such as those found in high-speed dental drills, come in contact with other metal parts creating friction, microfinishing is fundamental for proper function.

Unfortunately, virtually all metalworking operations including cutting, stamping, welding and forming roughen a metal surface. When that metal surface is then forced to work in friction zones, overall performance often suffers.

When properly applied, electropolishing can reduce microfinish values by 50% with a removal of .0005" from the surface. This often helps to bring the stock material down to the manufacturer's desired size. In dental applications, an improved Ra finish makes the plastic-to-metal assembly function easier.

Electropolishing is especially well suited for improving microfinish values on complex or fragile parts. Many other microfinish improvement methods such as grinding, lapping, vibratory finishing, or other mass finishing are not suitable on multi-faceted or fragile parts.

*By improving Ra values, electropolishing helps achieve desired microfinish and optimal part function.*

The right microfinish on dental and orthodontic parts and tools is crucial for optimal part performance. In critical applications such as implants and surgical equipment, electropolishing is the preferred option for achieving the desired microfinish values.





# ULTRACLEANING & DECORATIVE FINISH

Perhaps one of the most well-known benefits of electropolishing is its ability to create a bright and uniform finish. From implants to instruments, a bright and uniform surface on dental instruments is a sign of cleanliness that dentists and patients expect.

Electropolishing removes contaminants embedded during the manufacturing process to give handles and other instruments a bright, passive finish. Fabrication processes such as stamping, grinding, machining and heat treating all are employed to transform a metal bar, casting or sheet into a finished part. Most metalworking processes leave a metal surface porous and spongy, a condition called an “amorphous layer” of smeared metal which can be observed under 100X-300X magnification. This amorphous layer has significant air space that is perfect for trapping bacteria or water/ chemicals. Electropolishing creates an ultraclean surface by dissolving the amorphous layer and leaving a smooth, burr free virgin metal surface. Research has proven that in addition to being smoother, more corrosion resistant and easier to clean, electropolished surfaces are highly resistant to biofilm production. When electropolishing machined dental instruments or components with tight tolerances, a skilled electropolisher will tightly control the amount of metal removal within +/- .0001” - .0002” of their total stock removal target. Because of the ability to precisely control the amount of stock removal, parts are left shiny and bright without knurled areas becoming too smooth or threads becoming too sloppy for example. If a slightly less reflective surface is desired, oftentimes parts are first bead blasted and then electropolished to achieve a more satin finish that is still free of microburrs, corrosion resistant, ultraclean, aesthetically uniform/appealing and easy to clean.

*A uniform and clean appearance aids in ensuring patient confidence by signaling a sanitary surface.*

## COMMONLY ELECTROPOLISHED PARTS

- Dental Handles
- Instruments
- Implants
- Cassettes
- Blades



# COLOR ANODIZING

*Improve part identification with vibrant colors.*

Color anodizing creates a numerous array of colors without adding dyes or other foreign material to the titanium alloy, making it a great choice for dental instruments. Because contaminant-free parts are a top concern for the dental industry, the method of coloration through natural titanium oxides is appealing to manufacturers. This creates biocompatible instruments. In addition, this anodizing treatment is long lasting, resisting discoloration or fading.

The color anodizing is used not only as a decorative finish, but also as a means of color-coding parts for size and function identification. This treatment is often used on dental tips and periodontal curettes.

Color anodizing offers a variety of benefits for medical device manufacturers including:

- color stability
- decorative finish
- highly sanitary
- visual identification





# PASSIVATION

*Clean and remove contaminants from stainless steel parts.*

Chemical passivation is another option for cleaning stainless steel parts manufactured for the dental industry. The process utilizes either nitric or citric acid and is designed to remove free iron and other exogenous contaminants from the surface of the parts. This chemical cleaning process may be suitable for some dental instruments to remove contaminants resulting from machining or stamping operations.

The passivation process restores the material to its original mill condition and corrosion specifications. However, passivation is not suitable for all alloys and can cause an adverse reaction if not performed properly. Additionally, passivation is not effective in removing oxide scale or heat tint resulting from heat treating or welding.



## ELECTROPOLISHING VS. PASSIVATION

Electropolishing and passivation are widely used finishing operations. While they are both chemical processes, results vary greatly. While passivation is designed to increase the corrosion resistance of stainless steel parts, it does not offer the additional benefits or advantages that electropolishing does. These include:

- removal of surface burrs
- microfinish improvement
- fatigue life improvement
- bright, decorative finish
- effective on nearly any type of metal
- removal of heat tint and oxide scale
- ultracleaning

In addition to these benefits, the electropolishing process results in 30 times greater corrosion resistance than passivation. As a more aggressive and comprehensive operation with longer-lasting benefits, electropolishing offers unique advantages for a higher quality finish required in the dental industry.

## CASE STUDY: ELECTROPOLISHING DENTAL INSTRUMENTS

Dental instrument manufacturers were some of the first to understand the importance of and incorporate electropolishing into the design of their components. Able has been electropolishing dental instruments from the 1960s up to the present day and has been an integral final step in a multi-step manufacturing process that has stood the test of time. Many of the instruments dentists use are the first things their patients see when they walk in the room. It's important that these instruments not only be easy to clean and resistant to corrosion but also have a clean and uniform professional appearance.

Manufacturing of reusable dental instruments can be a dirty process with oils, metal shavings, heat discoloration and shop dust. Microscopic burrs, surface roughness and discoloration are not always preventable in machining, stamping, cutting, welding and grinding operations, but that is where electropolishing can help. Electropolishing is the choice finishing method for various reasons depending on the component in question. Electropolishing is chosen over mass finishing or mechanical polishing processes that may distort thin stampings or intricate laser cut details and provide an inconsistent finish or worse, damage parts. At Able, once a part has gone through the sampling process and the proper processing parameters are solidified, the part is given a permanent engineering record number corresponding to a specific set of work instructions - the process will be very repeatable and consistent from part to part and lot to lot (+/- .0001" variation). Mechanical polishing or mass finishing may provide a polished surface, but will not also offer the corrosion resistance and microdeburring of complex shapes that electropolishing can. Mechanical finishing methods may even embed more contaminants into the surface as the metal is smeared increasing the risk of corrosion. Electropolishing on the other hand removes a skin of metal from the part, thus removing any embedded contaminants and micro burrs. Passivation can help increase corrosion resistance of stainless steel machined and stamped parts, but lacks all of the other benefits that electropolishing provides regarding microfinish improvement and can be up to 30 times less corrosion resistant than electropolishing.

Furthermore, certain stainless alloys such as 303 stainless (which many dental handles are made from) are susceptible to flash attack when passivated. If flash attack does occur during passivation the 303 parts in question would actually rust sooner than ones which had not been treated at all, not to mention handles that had been electropolished which have been proven to last much longer in salt spray and humidity testing. A rough surface on a dental instrument, or an accessory such as the stainless steel cases in which the instruments are organized and sterilized, can be a prime hiding spot for harmful bacteria that could ultimately transmit disease to a patient. The smoothing effect that electropolishing has on metal surfaces makes for parts that rinse and dry better when sterilized and the extraordinary passivating effect that electropolishing has on stainless and titanium surfaces enables the parts to last through more cycles of use and sterilization. Blades used in oral surgery can also be made sharper and to cut cleaner when electropolished as a final step after grinding. Manufactures of dental instruments continue to send their parts to Able Electropolishing as the last step in their operation to reap the reward of the multiple benefits that the electropolishing process offers all in one cost effective operation.



# LASER MARKING

*Brand and improve instrument identification.*

Whether you're looking to brand your dental instruments or ensuring proper identification of tools based on their sizes or uses, laser marking is the ideal process for marking dental instruments.

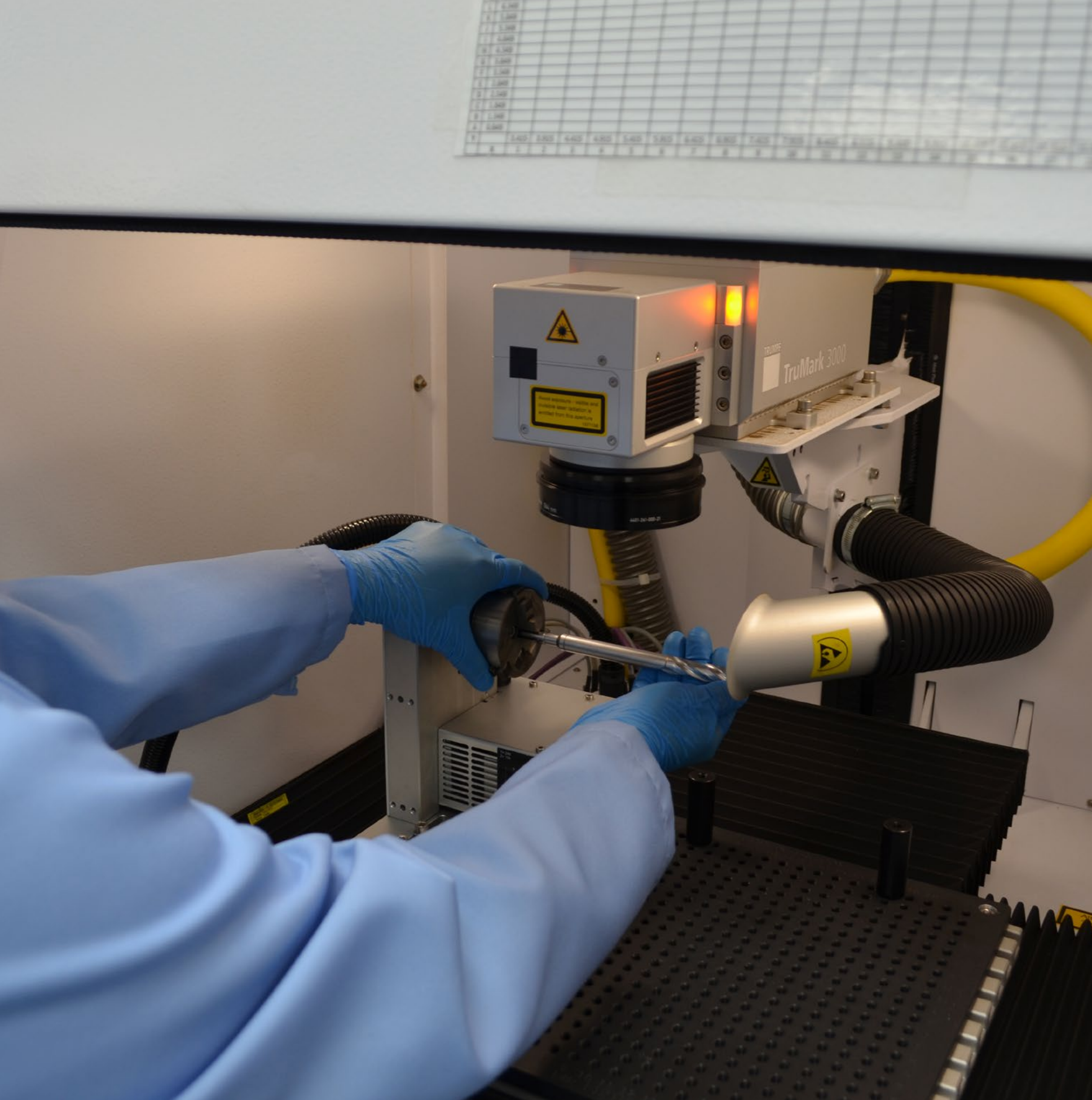
Drill bits and other size-specific components must be easily identified. Laser marking can ensure proper identification of these critical tools.

Recent updates to the Food and Drug Administration (FDA) regulations require parts used in medical applications to have a unique identifying mark to allow for more accurate reporting and analyzing of information regarding the device when an adverse event occurs. The UDI measures, intended to improve patient safety, allow for enhanced tracking and accountability.

The laser marking process is 100% biocompatible and doesn't interfere with the function of parts used in dental applications.

Thanks to the advanced Trumpf TruMark Laser Marking System, which has X, Y and Z stages, as well as rotary indexers. The following marks can be easily achieved:

- flat and 3-dimensional components up to 18.7" high
- cylindrical products
- alphanumeric characters in any font
- any logo, shape or other form of identification including the 17 most common barcodes including Code 39, Interleaved 2 of 5, EAN, Code 128A and CODABAR.





# ABOUT US



Founder Zen Pokvitis

## METAL FINISHING EXCELLENCE SINCE 1954

Production and engineering breakthroughs achieved during WWII led to new and exciting metal finishing technologies as industry shifted from the war economy. Our founder, Zen Pokvitis, was on the leading edge of those developments and focused his chemical background on production applications for electropolishing. That experience in chemical formulation and equipment design led to the founding of Able Electropolishing Company in 1954, which began focusing on the needs of metalworking companies nationally.

## A COMMITMENT TO ENVIRONMENTAL SUSTAINABILITY

Able continues to make large investments in our facility to make sure we are in compliance with the stringent environmental guidelines now being enforced by federal, state and local regulatory agencies. Our investment in practices that support environmental sustainability means we're ready to serve our customers today and in the future.

## THE NEXT GENERATION OF INNOVATION, SERVICE & EXPERTISE

Today, Able Electropolishing is America's largest electropolishing specialist, employing more than 180 people on three shifts at our 40,000 sq. ft., state-of-the-art facility in Chicago, Ill. Thousands of companies in nearly every industry world- wide utilize Able technology for their metal parts.

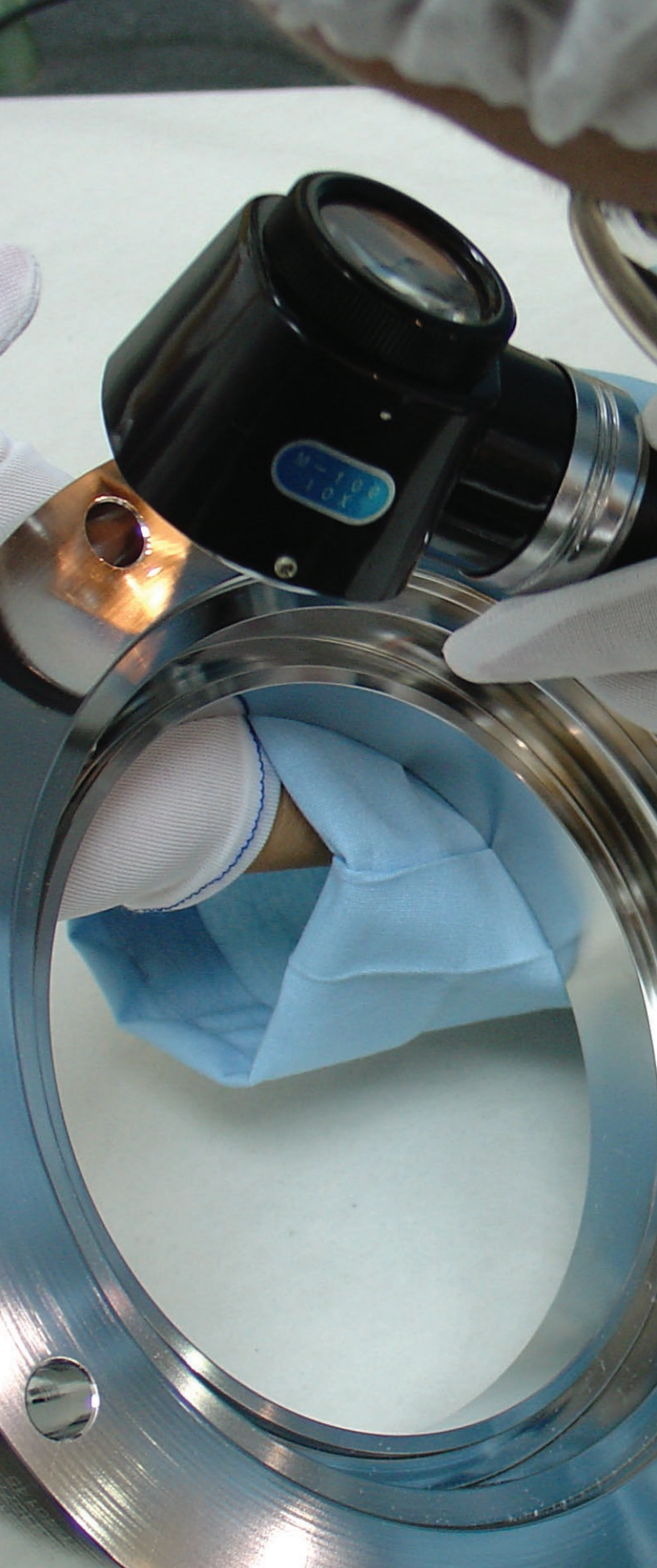
Though our technology plays a vital role in serving customers, the traditions of service and attention to quality are what make Able Electropolishing a unique company.

Our entire company is tuned to the concept of doing the job right the first time. We have long recognized that metal finishing is the "last step" for many companies designing and producing metal parts, and we are often the lifeline for companies faced with assembly line shutdowns due to parts that are late or malfunctioning. Being part of the solution and meeting tough deadlines has established Able as the preferred vendor for so many companies.

## OTHER SERVICES WE PROVIDE

While electropolishing is our signature service, we also have other metal finishing capabilities to enhance your parts. In addition to electropolishing, our other services include:

- Passivation
- Contract Cleaning
- Titanium Color Anodizing
- Laser Engraving
- Bake Out
- Custom Packaging



# THE ABLE DIFFERENCE: EXPERTISE & EFFICIENCY

## THE ABLE DIFFERENCE: EXPERTISE & EFFICIENCY

Able Electropolishing takes pride in our exceptional, expedited electropolishing process. By providing our signature metal finishing service for dental and orthodontics manufacturers in a timely manner, we assist our customers who need improved fit and function, as well as, corrosion-resistant equipment that meets industry standards.

## INDUSTRY STANDARDS

We meet the following industry standards:

- AMS 2700
- ASME BPE
- ASTM A380
- ASTM A967
- ASTM B912
- ASTM F86

## QUALITY STANDARDS & CERTIFICATIONS

At Able Electropolishing, we strive to satisfy our customers with every metal finishing job we complete. This includes adhering to international standards of excellence, ensuring that we consistently provide a variety of high-quality metal finishing services. We meet standards set by:

- ASTM (The American Society for Testing and Materials)
- ASME (The American Society of Mechanical Engineers)
- SAE (The Society of Automotive Engineers)
- ISO (The International Organization for Standardization)



We are also an ISO 9001 and ISO 13485 registered company. These standards allow us to provide finishing services for critical parts in industries like pharmaceutical, medical device manufacturing, dental, aerospace, automotive and more.

By meeting or exceeding the various standards and quality management system requirements set by these organizations, we can provide services like electropolishing, passivation and more while giving our clients a sense of true security and consistency in our quality.

When you work with Able Electropolishing, you can enjoy the peace of mind that we are meeting high standards, whether you're sending us one part or thousands. We continue to add state-of-the-art equipment to keep at the forefront of our industry.





**E: SALES@ABLEELECTROPOLISHING.COM**

**P: 888.868.2900**

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### **THE ABLE ELECTROPOLISHING DIFFERENCE**

Since 1954, Able Electropolishing has been refining its technology to improve the fit and function of metal parts. No matter whether your part is small or large or the industry you work in, our electropolishing process gives you a unique combination of benefits you won't find with other metal treatments.

Find out more at: [ableelectropolishing.com](http://ableelectropolishing.com)