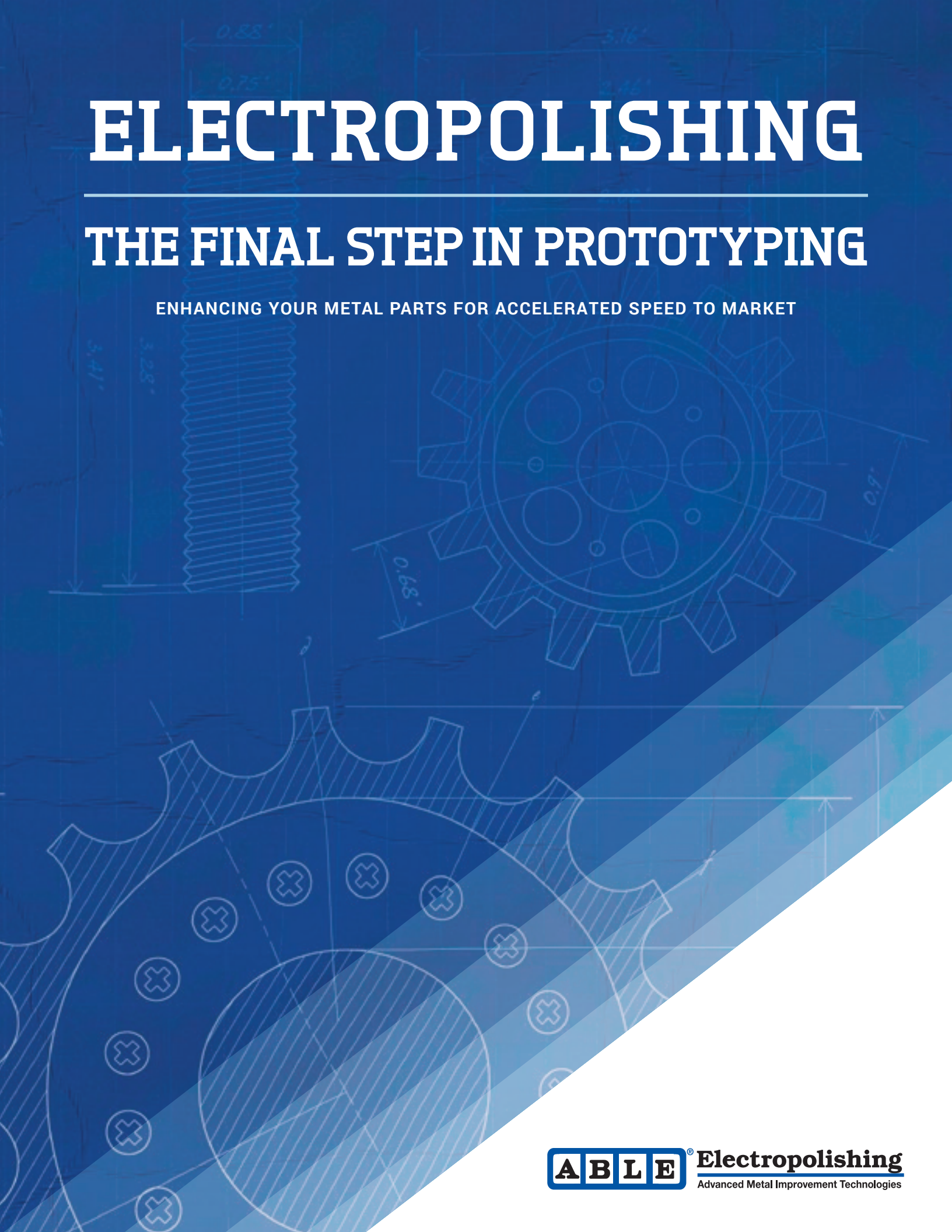
ELECTROPOLISHING

THE FINAL STEP IN PROTOTYPING

ENHANCING YOUR METAL PARTS FOR ACCELERATED SPEED TO MARKET



ABLE® Electropolishing
Advanced Metal Improvement Technologies

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WHAT IS ELECTROPOLISHING?

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.

When speed to market is critical, electropolishing offers the necessary part enhancements needed in the final step of production.

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

More recently, electropolishing has been utilized in many prototyping methods, including investment casting, photochemical machining, injection molding, laser cutting, metal stamping, 3D printing, direct metal laser sintering and electrical discharge machining. Following the electropolishing process, 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
- Specialty Alloys
- Nickel Alloys
- Specialty Steels
- Carbon Steels
- Tool Steels
- Aluminum
- Titanium
- Nitinol

// WHAT IT DOES

While the process 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 cleaning and drying steps to remove clinging electrolytes. 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.

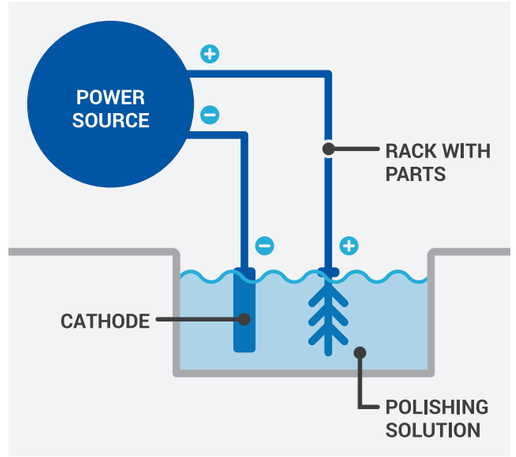


Figure 1

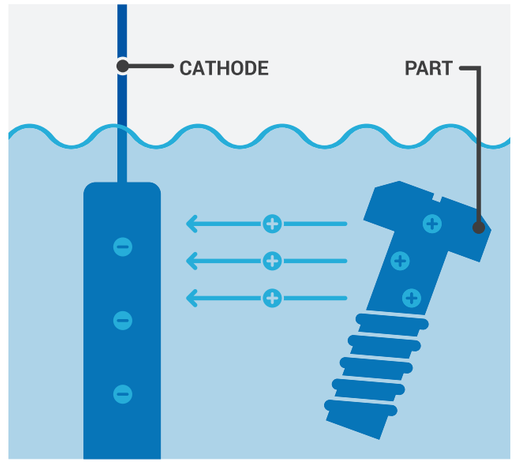


Figure 2

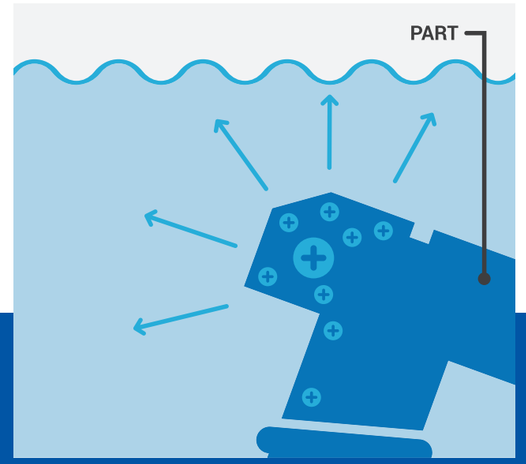


Figure 3

DIRECT METAL LASER SINTERING

Direct metal laser sintering (DMLS) is an additive rapid manufacturing prototyping method used to create production tools for the automotive, aerospace, dental and medical industries.

Using CAD models, metal powder builds up in layers and is fused into a solid part without tooling, creating products with speed and accuracy, even in a matter of hours. These parts are ideal for small prototypes used in functional tests.

> Stainless steel and cobalt chrome alloys are used for DMLS parts and often have a raw finish that is very similar to a fine investment casting.

These parts can benefit from ultra-cleaning and improved corrosion resistance, as well as the decorative finish, electropolishing provides.

THE BENEFITS

// ULTRACLEANING

Electropolishing can be used in conjunction with other traditional mechanical finishing methods to leave the part clean and free of surface contamination. Most notably, electropolished parts have an ultraclean finish free of lingering surface impurities, such as oils, embedded scale, debris and more.

// DECORATIVE FINISH

Many DMLS parts have complex shapes that are difficult to polish. Electropolishing can provide a clean, bright finish in difficult to access areas of complex, customized geometries. After undergoing electropolishing treatments, metal parts have a noticeably bright, shiny appearance that cannot be achieved using traditional metal finishing methods.

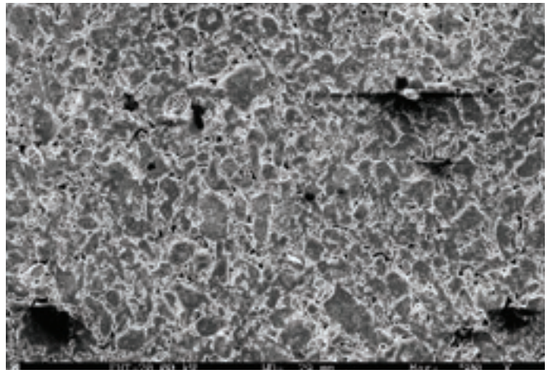
// CORROSION RESISTANCE

Surfaces with heavy contamination often do not respond well to passivation treatments alone. These parts require more aggressive metal finishing methods, like electropolishing, to enhance their corrosion resistance.

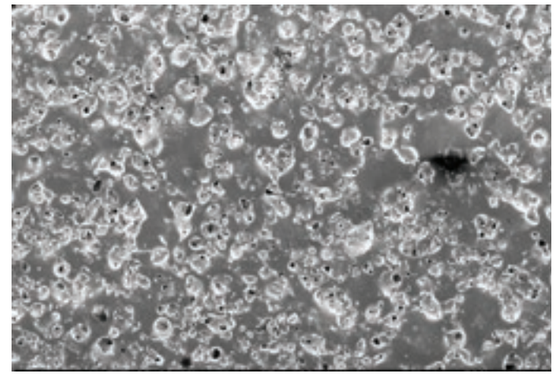
By eliminating embedded contaminants and surface imperfections, electropolishing provides 30 times greater corrosion resistance than passivation alone. Electropolishing can also be performed on almost any metal alloy, making it a desired method for DMLS prototyped parts.

Sintered Part

CASE STUDY



Before Electropolishing



After Electropolishing

// THE PROBLEM

The customer was looking for a way to improve the finish and provide an ultraclean surface for DMLS-created parts used in a medical application.

They needed a finishing method that would not adversely affect the porous surfaces that are suitable for better osteointegration.

// THE SOLUTION

Electropolishing was able to clean the surface of the DMLS part and minimize the mechanical finishing required without damaging the textured surface.

Following electropolishing treatment, the part had a clear, shiny and ultracleaned surface with improved oxidation resistance.

INVESTMENT CASTING

THE BENEFITS

// ULTRACLEANING

Investment casting, along with other prototyping methods, can create metal parts that have impurities left behind. Electropolishing can be used to remove contaminants, creating a surface that is more resistant to corrosion.

// DECORATIVE FINISH

After investment casting has been completed, prototyped parts exhibit a dull finish.

Electropolishing can enhance parts for a bright, clean finish that is long-lasting. These parts also have a smooth surface that combats against oxidation, even in harsh conditions.

// CORROSION RESISTANCE

For prototypes with custom shapes, such as those created through investment casting, corrosion resistance is the utmost importance.

> Electropolishing is an effective way to prevent corrosion, whereas, other methods, like passivation, provide a lesser level of protection.

Electropolishing removes embedded impurities for increased part protection and longevity.

Investment casting is a prototyping method that uses a wax mold to create metal parts.

Investment casting is typically used for metal parts that require complex and thin wall castings, as well as for parts with highly customized shapes and edges that cannot be achieved using conventional methods.

Because investment casting can produce parts with highly unique and intricate characteristics, many industries, including aerospace, medical and others, rely on this method to develop new parts.

> Following electropolishing, investment-cast parts have a smoother, ultra clean surface with a decorative finish, as well as enhanced corrosion resistance.

CASE STUDY

// THE PROBLEM

The customer had a 17-4 PH stainless steel investment casting used in the marine industry. The parts, as cast, were not passing stringent salt spray testing for corrosion resistance.

The parts were sent through various blasting and passivation operations with no positive results. Ultimately, the client decided to have electropolishing performed on the parts.

// THE SOLUTION

The parts were electropolished to remove .0008" total material. After the electropolishing process was completed, the parts were cleaned of all embedded scale, oxides and abrasives.

The resultant surface was free of impurities, and all surface cracks and fissures were eliminated or reduced, effectively extending the parts' lifespan.

The parts exceeded salt spray requirements by 210%.

Before Electropolishing

After Electropolishing

PHOTOCHEMICAL MACHINING

Photochemical machining is a prototyping process used to create detailed parts. This process is ideal for manufacturing parts created from extremely thin metal, as they can be machined without distorting the material.

Many companies use photochemical machining to manufacture their prototypes because the process creates precise parts at fast rates. Last-minute design changes are also much easier and less costly to accommodate with photochemical machining.

> The process is often used by the medical, aerospace, dental, military and electronics industry.

After undergoing electropolishing, metal parts are consistently deburred, microfinished and ultra cleaned without altering shape or compromising parts' performance.

THE BENEFITS

// MICROFINISH IMPROVEMENT

Because photochemical machining works with such delicate pieces of metal, they need a finishing process that can improve surface finish without distortion.

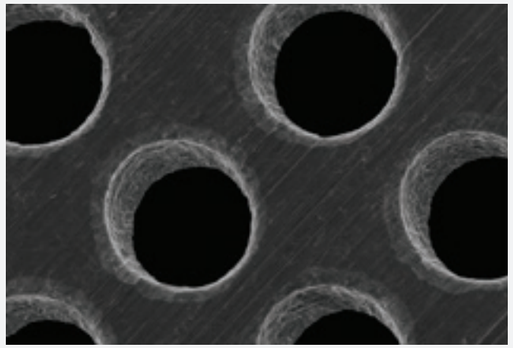
Electropolishing can provide the surface finish companies need. By removing .0005" material from each surface, electropolishing typically reduces microfinish values by approximately 50 percent. The process is better suited for improving the surface finish on fine, delicate parts compared to grinding or lapping.

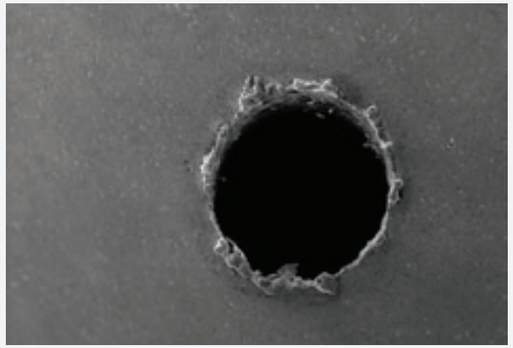
// DEBURRING/RADIUSING EDGES

During the electropolishing process, the transfer of metal ions occurs more rapidly on corners or edges. Properly controlled electropolishing can remove burrs and radius edges of complex or fragile parts that are not well suited for tumbling or vibratory finishing.

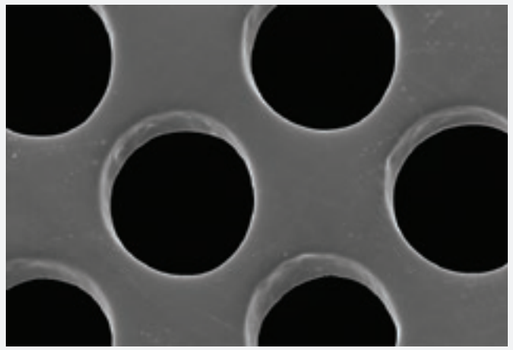
// CORROSION RESISTANCE

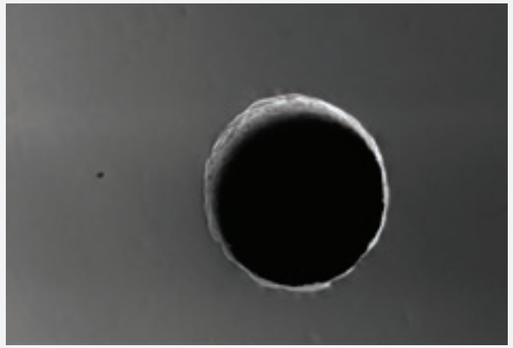
To ensure parts last well into the future, they must have exceptional resistance to oxidation. Electropolishing removes the outer layer of metal and its embedded contaminants, improving the corrosion resistance for photochemical machined parts. After parts have been electropolished, they have a smooth surface that greatly reduces the possibility for corrosion sites.





Before Electropolishing





After Electropolishing

CASE STUDY

// THE PROBLEM

The customer was looking to improve the finish of stainless discs with critical holes manufactured by photochemical machining. Manufactured from very thin material, the parts were left with a burr from the etching process. The customer needed a way to consistently deburr the part without damage or distortion that can be caused by traditional mechanical deburring methods.

// THE SOLUTION

Electropolishing not only left the parts with an ultra clean, bright finish, but it also rounded the edges of the critical holes in the parts.

Electropolishing effectively removed micro burrs on the part, performing well on the thin material without distorting the shape of the part.

The part also had improved corrosion resistance following electropolishing.

METAL INJECTION MOLDING

Commonly used in the industrial, medical, dental, aerospace and automotive industries, metal injection molding (MIM) allows for shaping of complex parts in a single operation in high volume.

THE BENEFITS

// DEBURRING/RADIUSING EDGES

Electropolishing removes a thin layer from the surface to free parts from foreign materials. Electropolished parts can comply with strict sanitation and cleanliness standards for applications in a variety of industries, including food service, automotive, aerospace, pharmaceutical, medical and more.

// CORROSION RESISTANCE

Electropolishing is the most ideal method for preventing corrosion, as it provides 30 times greater resistance than passivation. Unlike conventional methods of passivation, electropolishing actually removes the outer skin of metal and embedded contaminants. Once these impurities are removed during the electropolishing process, the metal surface is smooth, eliminating areas that could be initiation sites for corrosion.

// MICROFINISH IMPROVEMENT

Mechanically polishing small, hard-to-reach features of complex, high volume items that are often created by the MIM process is not cost effective or consistent.

> **Electropolishing is the ideal solution, as it can improve the microfinish on critical surfaces by removing a uniform layer that does not distort the surface of the parts.**

Electropolishing allows for a concentration of current on the peaks of a surface, thereby reducing microscopic peaks and causing a leveling action. By reducing the surface peaks, the microfinish values are reduced as well. Moreover, the electropolishing process effectively extends the life of a part by removing stress cracks and creating a smooth, even finish.

In this process, finely-powdered metal mixed with a binder material is injected as a liquid into a hollow mold to create a prototype part. The part is then cooled and de-molded. Due to the fragile and porous nature of the resulting parts, metal parts made using MIM require the metal to be condensed in a furnace process, or sintering. The sintering process fuses the parts into a solid shape.

> **Parts made using MIM are left with burrs and surface imperfections, which can be effectively removed or reduced by utilizing electropolishing.**

CASE STUDY

// THE PROBLEM

The customer was looking for a way to improve the surface finish of critical sealing surfaces in an automotive application. Mechanically polishing the small, hard to reach features of the high volume item would not be cost effective or consistent.

Electropolishing was suggested as a solution. Extensive testing was performed on the parts by the end-user to pinpoint an appropriate Ra value on the surface of the lips to ensure a proper seal in order to minimize leakage and maximize effectiveness and longevity of the system. Through a series of sample lots, the correct amount of material removal was determined to maximize improvement on the critical sealing surfaces.

// THE SOLUTION

Decreasing roughness average values and improving microfinish directly correlates to more functional, longer lasting sealing surfaces.

By electropolishing the molded surfaces, Able improved the microfinish on the critical surfaces, thus improving functionality in an economical and accurate manner.

ELECTRICAL DISCHARGE MACHINING

Electrical discharge machining (EDM) is a prototyping method commonly utilized by the automobile and aerospace industries to create unique shapes that are difficult to create with conventional tooling.

THE BENEFITS

// MICROFINISH IMPROVEMENT

Electropolishing can eliminate contaminants and burrs on metal parts. By removing the outer skin of material, electropolishing removes the recast layer to give the part a smoother surface and eliminates anomalies. Electropolished parts have a decreased likelihood for defects such as micro cracks, which, in turn, can effectively extend the life of the parts.

// ULTRACLEANING

Electropolishing can greatly enhance metal parts, leaving them free of surface impurities such as embedded scale, residual dust and other contaminants. Once parts have been electropolished, they are clean, passive and free of foreign materials. Manufacturers can then implement the parts into devices for various industries that require the utmost sanitation and cleanliness, including food processing, pharmaceutical, aerospace, medical and more.

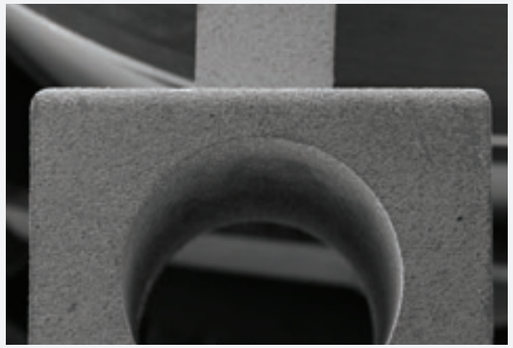
// CORROSION RESISTANCE

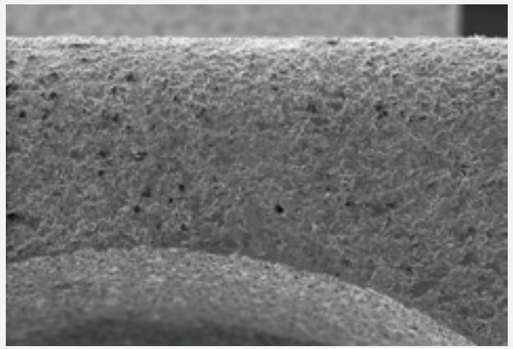
Unlike conventional methods of passivation, electropolishing removes the outer layer of metal and embedded surface contaminants. Electropolishing can eliminate embedded impurities by removing material in a uniform fashion, creating a smooth surface with improved corrosion resistance for metal alloys, including stainless steel, aluminum, copper, brass and carbon steel. While all of these alloys are more resistant, we do not routinely recommend electropolishing as a substitute for coatings designed to protect a metal part in harsh environments.

Wire EDM is performed by a series of recurring electrical discharges between a cutting tool that acts as an electrode and a conductive work piece to shape both large and small parts.

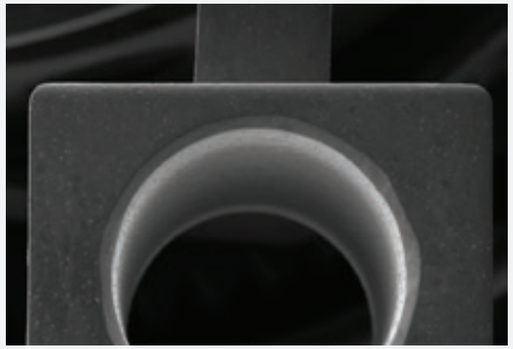
> Although the wire EDM can produce a fine finish for metal parts, the process leaves a recast layer that is composed of re-deposited bits of metal.

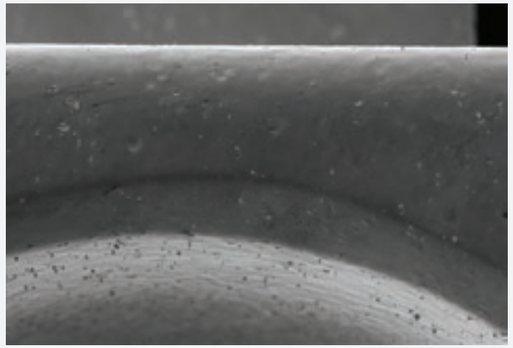
Electropolishing can improve EDM parts by removing surface contaminants for a clean, corrosion-resistant finish and enhanced part longevity.





Before Electropolishing





After Electropolishing

CASE STUDY

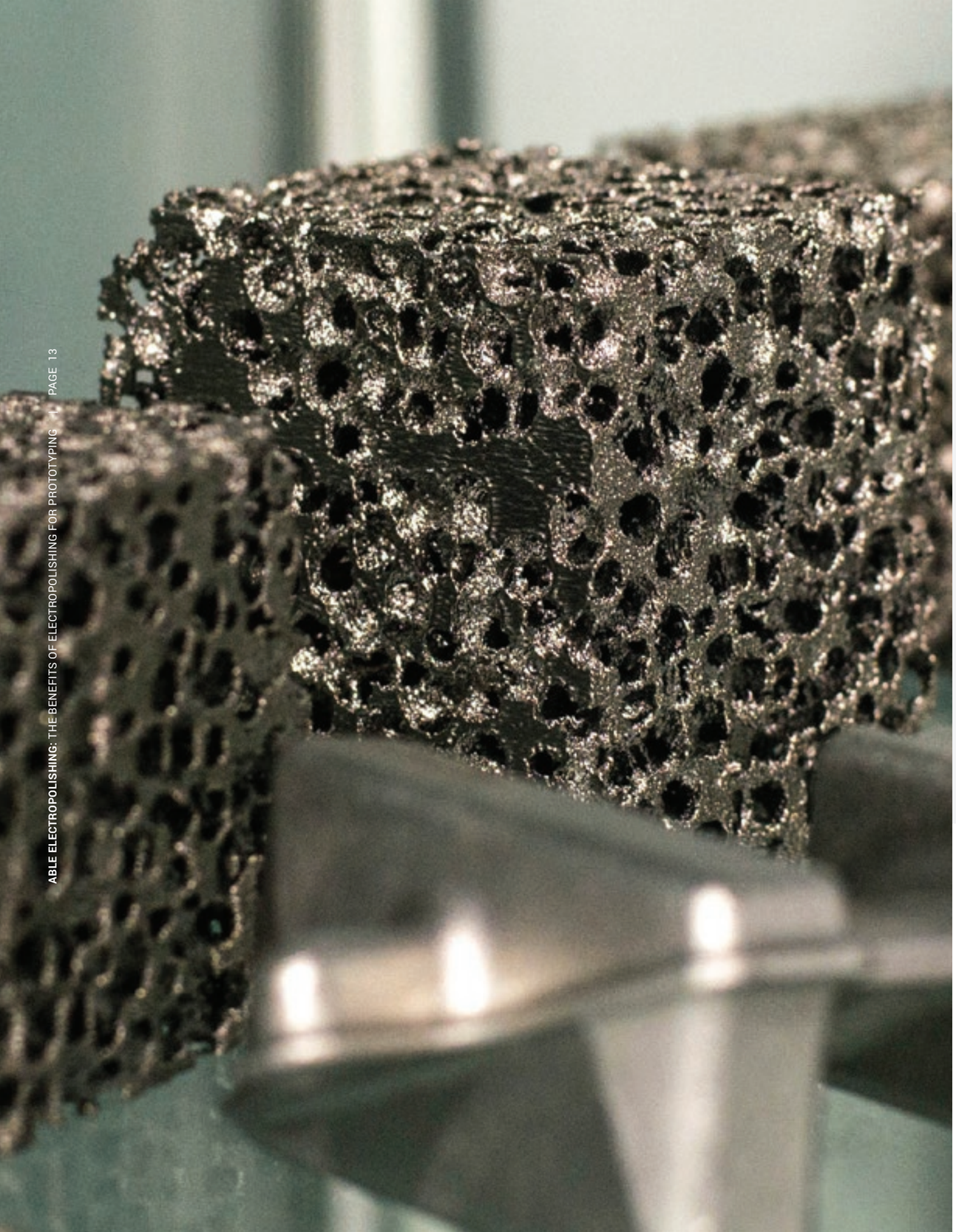
// THE PROBLEM

This critical aerospace part created through wire EDM had a rough surface and recast layer that, without subsequent finishing techniques, could have been susceptible to corrosion and micro cracks. These micro cracks, in turn, could potentially interfere with other moving parts. In addition, parts were not falling into specified tolerance ranges as called out by the blueprint. The customer approached Able to find an effective solution to remove the recast layer and meet specifications.

// THE SOLUTION

Electropolishing provided a controlled removal that created a microfinished surface area, which aided in solving both of these problems.

We were able to remove the recast layer, smooth the surface and size the part to within the strict tolerance range required by the industry.



3D PRINTING

THE BENEFITS

// ULTRACLEANING

Following 3D printing, parts may have impurities on surfaces that other metal finishing methods cannot eliminate. These parts can be enhanced through electropolishing. After electropolishing, components will be free of foreign materials that could compromise the sanitation or safety of parts.

// CORROSION RESISTANCE

Conventional methods of passivation are often not sufficient to improve corrosion resistance for 3D printed parts.

> Electropolishing can enhance corrosion resistance 30 times more than passivation by removing the outer skin of metal that contains embedded contaminants and other surface impurities.

Inclusions that could be initiation sites for corrosion are also successfully eliminated through electropolishing.

// MICROFINISH IMPROVEMENT

Critical surfaces of both large and small, complex items created through 3D printing require a finishing technique to prevent burrs or micro cracks from developing. Hand polishing, however, often proves to be costly and provides inconsistent results.

> Electropolishing can even improve the microfinish on fragile or multi-faceted parts when other methods like lapping or grinding cannot.

Electropolishing can also provide the necessary final finishing of items such as medical implants after mechanical finishing, leaving them with microfinished improvements that make the part free of burrs and prevents contaminants from entering the body.

3D printing is achieved using an additive manufacturing process, where successive layers of material are laid down in different shapes. 3D printing is often used in numerous industries for prototyping for its advantages over traditional methods.

3D printed parts may have burred edges or possible corrosion sites that can be removed through electropolishing.

3D printing allows companies to produce parts in small numbers without expensive short-run costs, enabling them to make prototypes on demand. Design changes can also be made quickly and easily because there are no tooling or machining constraints.

LASER CUTTING

Laser cutting is a precise method for creating a design from a given material using a CAD file to guide it. The process uses a high-powered light beam to cut material based on computer-controlled parameters.

As the laser guides its beam along the material, everything in its direct path is vaporized, burned or melted.

The setup process is relatively simple and efficient. Newer laser cutting systems can even simulate a job, giving operators an idea of how long the process will take while storing configurations, which can be recalled at a later time for even quicker changeover rates.

> After laser cutting, parts may need improved microfinishing and ultracleaning to prevent corrosion.

Electropolishing successfully deburrs parts, leaving them with smooth, passive surfaces.

THE BENEFITS

// MICROFINISH IMPROVEMENT

Metal parts can greatly benefit from the microfinish improvements electropolishing provides. During the electropolishing process, a concentration of current causes a leveling action and reduces microscopic peaks. This, in turn, enhances the parts' microfinish and helps extend the life of the part.

// ULTRACLEANING

Untreated metal parts are often riddled with harmful contaminants that create safety and sanitation issues and could even impact part performance. To solve these issues, parts can be electropolished for a bright, ultraclean finish free of oils, residual dust and other foreign debris.

// CORROSION RESISTANCE

Laser-cut parts have embedded contaminants and other surface impurities. Without being subjected to a secondary finishing operation, these metal parts could be susceptible to harmful corrosion. After electropolishing, laser-cut parts will have improved corrosion resistance.

// EDGE RADIUS/DEBURRING

Laser cutting often leaves parts with sharp edges. To radius these edges, parts can be submitted for electropolishing. Electropolished parts exhibit smoother edges free of harmful burrs that could compromise their integrity and longevity.

CASE STUDY

// THE PROBLEM

The customer was looking for a way to radius the edges of a laser cut part before forming. The parts are used in an appliance application and require rounded edges to prevent injury to employees during part handling.

// THE SOLUTION

By transferring metal ions on the corners, electropolishing left the part with smooth radiused edges ready for forming and assembly.

The part also had improved corrosion resistance, as well as an ultraclean surface.

METAL STAMPING

Metal stamping can be applied to a variety of alloys for a number of applications. The process involves the placement of sheet metal into a press where a tool and die surface forms the metal into the desired shape.

THE BENEFITS

// MICROFINISH IMPROVEMENT

To improve the surface finish of metal-stamped parts, many companies will submit them for electropolishing, which is better suited for fragile parts than grinding or lapping. Removing .001" (.0005" per surface) of surface material from a part can reduce its microfinish values by approximately 50%.

// DEBURRING/RADIUSING EDGES

During electropolishing, the transfer of metal ions occurs more rapidly on the edges or corners of the metal parts. To achieve smooth edges free of burrs, parts can be electropolished. This process is ideal for delicate parts that cannot undergo tumbling or vibratory finishing.

// CORROSION RESISTANCE

Metal-stamped parts that receive passivation treatments or no metal finishing at all can be susceptible to corrosion.

Electropolishing can successfully reduce these initiation sites, keeping the parts smooth and free of surface contaminants.

Used in a variety of industries such as agriculture, aerospace, medical and automotive, parts manufactured using metal stamping can be produced at a very high rate.

> Over the past few years, metal stamping has been replacing other metal forming processes, such as forging and die casting, because of its low-production costs.

Electropolishing parts that have been stamped removes harmful burrs and cracks and helps prevent corrosion.

CASE STUDY

Before Electropolishing

After Electropolishing

// THE PROBLEM

The customer needed parts to be clean and free from contaminants, and have a bright finish.

Unlike mechanical polishing methods, electropolishing removes a precise and uniform amount of material.

// THE SOLUTION

The electrochemical polishing process removed a uniform layer of surface metal from the part, effectively stripping away imperfections and contaminants.

In the case of this particular part, we were able to electropolish removing .0002-.0004" of material from the thickness, creating a clean, bright and passive surface. As a result of electropolishing, the microfinish and corrosion resistance were also improved.

ABLE ELECTROPOLISHING

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 150 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 worldwide 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

Able Electropolishing takes pride in our exceptional, expedited electropolishing process. By providing our signature metal finishing service for prototype parts in a timely manner, we assist our customers in speeding new products to market.

// INDUSTRY STANDARDS

We meet the following industry standards:

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

We are also an ISO 9001: 2008 and ISO: 13485 registered company. These standards allow us to provide finishing services for critical parts in industries like pharmaceutical, medical device manufacturing, aerospace, automotive and more.

// EXPEDITED SERVICES FOR SPEED TO MARKET

When you work with Able Electropolishing, we'll respect your project timeline, processing your metal parts in accordance to your schedule. Our team works on three shifts, five days a week to ensure your metal parts are processed in a timely manner. For your convenience, we offer multiple delivery options, including same-day, next-day and standard, to return your electropolished prototype parts as quickly as possible.

// 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)*

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.

ABLE® Electropolishing
Advanced Metal Improvement Technologies

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// THE ABLE ELECTROPOLISHING DIFFERENCE

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