METAL FINISHING

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Quality and Service Through Experience

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FINISHING CAPABILITIES & SPECIALTY PROCESSES

Superior Finishing

Conventional Anodizing
- Spec MIL-A-8625
- Type II Class I & Class II
- Corrosion Resistant & Increased Surface Hardness
- Clear or Color
- 19 Assorted colors add beauty & durability
- Custom Color Matching
- 16' Tanks

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- Precision Close Tolerance Work
- Uniform Buildup
- Gray or Black
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Powder Coating
- Production Runs
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- Polyester & Polymer Coatings
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- Fast Turnaround

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- Alodine, Iridite or Chem Film
- Clear or Gold
- Corrosion Protection
- RoHS Compliant
- NCP Iridite
- Military & Aircraft Specification
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Electropolishing
- Brightens, Polishes & Deburrs Stainless Steel & Aluminum
- Eliminates Mechanical Polishing
- Total Passivation

Specialty Processes

Teflon® Coating
- Dry Film Lubricant
- Bonded Lubricant Coating
- Long Wear Properties
- Superior Lubricity

Passivation
- Spec QQ-P-35 Type II, VI, VII, VIII
- ASTM A 967-01
- ASM 2700 B
- 4' Tanks

Turco Cleaning
- Titanium Cleaning
- Military Specifications
- Excellent Bonding Properties

Selective Masking
- Selected Area Protected from Coating
- Maintains Exact Tolerances

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- Various Mediums: Glass, Cob, Sand
- 20' Booth

Humidity/Salt Spray Testing
- Military Specifications & ASTM
- Accelerated Corrosion Testing
- 4' Chambers

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- MIL-C-13924C, Class1
- Produces high quality, durable black finish

RELATED INFORMATION
- Average Turnaround Time 3-5 business days
- Expedite Service Available
- Individual or Proto-Type run on minimum-charge basis
- Certification of Standards Compliance available
- Centrally located in Orlando
- Shipping UPS or Designated Carrier

Member of AESF, AAC, MACF, PCI & SME

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Your Solution To Metal Finishing

FREE SAMPLE PART!

Check out our capabilities today with free processing of your sample part.

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METAL FINISHING

ELECTROPOLISHING

ELECTROPOLISHING PROCESS CAPABILITIES

- 200/300/400 series stainless steel
- RMS finish specifications
- Passivation & Turco cleaning
- 3-5 days normal turnaround or "hot" expedite
- Proto-type or high volume runs
- Abrasive Blasting
- Protective packaging

SOME INDUSTRIES SERVED:

- Surgical
- Medical
- Pharmaceutical
- Marine
- Stainless Fabrication
- Food Processing
- Automotive

SOME APPLICATIONS:

- Medical, Surgical and Dental Instruments
- Boating, fishing and swimming pool accessories
- Food industry equipment
- Pharmaceutical research equipment
- Meat and Fish Hooks
- Stampings, wire goods
- Aircraft Components, etc.

FEATURE & BENEFITS:

- Stress relief of surface.
- Removes oxide.
- Passification of stainless steel.
- Superior corrosion resistance.
- Hygienically clean surfaces.
- Decarbonization of metals.
- No Hydrogen embrittlement.
- No direction lines.
- Low-resistance welding surface.
- Reduce friction.
- Polishes and deburrs odd-shaped parts simultaneously.
- Radiuses or shapes edges depending on rack position.
- Reduces annealing steps.

Check out our capabilities today with free processing of your sample part.

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ELECTROPOLISHING

ELECTROPOLISHING produces a number of favorable changes in a metal part which are viewed as benefits to the buyer. All of these attributes translate into selling advantages depending upon the end-use of the product. These include:

- Brightening, smoothing, and deburring
- Removal of surface occlusions
- Increase in corrosion resistance
- Removal of directional lines
- Radiusing of sharp edges
- Improvement in adhesion of plating
- Reduction in polishing, buffing, and grinding costs
- Total passivation
- Oxide removal
- Reduction of surface friction
- Stress relieving of surface
- Sharpening of blades
- Removal of hydrogen

Electropolishing produces the most spectacular results on 300 series stainless steels. The resulting finish often appears bright, shiny, and comparable to the mirror finishes of "bright chrome" automotive parts. On 400 series stainless steels, the cosmetic appearance of the parts is less spectacular, but debarring, cleaning, and passivation are comparable.

Solutions are available to electro polish most common metals. Notable exceptions include cast alloys of zinc, aluminum, brass, bronze, and carbon steel. Investment cast stainless steels may also be difficult to electro polish to a satisfactory finish unless parts are solution annealed after heat treating. In general, only the 200 and 300 series stainless steels, certain tool steels, copper, and some single-phase brass alloys can be electro polished to mirror finishes. The principal effects on other types of metal are deburring, smoothing, improvement of surface finish, and increased adhesion of plated coatings.

Electropolishing produces a combination of properties which can be achieved by no other method of surface finishing. Mechanical grinding, belting, and buffing produce beautiful mirror-like results on stainless steel, but the processes are labor intensive and leave the surface distorted, highly stressed and contaminated with grinding media. The passivation methods commonly employed produce clean, corrosion resistant surfaces, but do not achieve the bright, lustrous appearance obtained by Electropolishing. Electroplating can produce extremely bright finishes, but the finish is a coating which can chip or wear off Electroplated surfaces may also exhibit hydrogen embrittlement which must be stress relieved in a separate step. Neither passivation nor electroplating can accomplish burr removal.

SPECIFICATIONS FOR ELECTROPOLISHING

Specifications for Electropolishing vary with the end use of the parts. Knowledge of the end-user's requirements can be of importance in designing an Electropolishing line. Top quality finishes usually require the greatest care and attention to detail in selecting the process steps to be followed.

The simplest requirements for electropolishing are for a "clean, bright, essentially cosmetic" finish. Results are judged primarily by appearance. This type of application may be satisfied with a relatively simple approach to the Electropolishing equipment and process.

Some specifications require a certain level of deburring without regard to cosmetic appearance. Inspection techniques vary from simple snagging tests on woven or knitted cloth to microscopic examination to evaluate the level of deburring.

Tests for passivation are spelled out in great detail by the Federal specification covering the various methods of chemical passivation. This publication even details the methods and sequence of operations to be followed. To our knowledge, there is no Federal or NEL-specification which permits substitution of Electropolishing for chemical passivation; however,- the finishes produced by Electropolishing meet or exceed the test results required to certify passivation of stainless steels.

The use of Electropolishing to improve surface finish is increasing rapidly, and many end user specifications now include photographic, or electron-microscopic examination. Definitions of surface finish such as RMS or Ra are frequently used.

Much attention has been placed on the application of Electropolishing to equipment used in food processing, pharmaceutical production, beverage manufacturing, and other ethical product systems. Special tests, such as the rate of bacterial growth on the finished part, may be required as a part of the quality acceptance procedure.

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HARDCOAT ANODIZING

In an effort to promote better understanding of the Process of Aluminum Hard coating, we offer the following facts and suggestions:

1. Hardcoat IS different; Hardcoat is NOT plating.

2. Hardcoat PENETRATES the base metal as much as it builds up on the surface and the term THICKNESS includes both the buildup and the penetration.

3. Hardcoating a shaft .002 thick will increase the diameter by only .002. Plating the same shaft .002 thick would increase the diameter .004, since plating is 100% surface build up.

4. Be positive before you machine your parts that you are allowing for the hardcoat buildup and not a plating buildup.

5. When you call for hardcoat, the use of the term "Build up per surface" will make it impossible to misunderstand what you are requesting.

6. Exacting dimensions can be maintained with the Hardcoat Process. Standard commercial tolerance is + .0005 on a coating thickness of .002. For closer tolerance requirements, consult the finisher in advance.

7. Allowing a tolerance on coating buildup means that you must machine closer than blueprint dimensions. For example: A shaft diameter which is to finish at 1.500 + .001 and is to be hardcoated .002 thick (.001 + .0001 buildup per surface), your planning should call out Machine to 1.498 + .0008", your part will then be to finish dimensions after hardcoating.

8. When a "V" thread is to be cut to allow for hardcoating, the formula is "Build up per surface", multiplied by "Four"; this will equal the pitch diameter change. A typical example is: Desired P.D. = .405/.4091 (7/16 N.F. Internal Thread) Coating Thickness .002 + .0002 (.001 + .0001 buildup per surface). Minimum buildup per surface is .0009 x 4 = .004 P.D. change. Machine P.D. to .4094/.4127.

HOW TO ORDER THE HARDCOAT PROCESS

To save time, trouble, and possible errors, information on the following four items must be known:

1. Alloy
2. Coat Thickness
3. Masking Requirements (if any)
4. Racking Instructions (if possible)

1. **ALLOY-** Hardcoat can be applied to virtually any aluminum alloy. However, since the coating builds up at different rates on each alloy in order to control coatings accurately, it is important to specify the alloy. Also, some alloys require different procedures from others. If the alloy is not properly designated, there is a possibility of damage.

2. **COATING THICKNESS-** Hardcoat may be provided in thicknesses ranging from a few .0001's to .008" or .009", depending on the alloy and the application. Like other coatings, Hardcoat changes the dimensions of the basic part. One half of the Hardcoat build-up and one half is penetration, i.e., .002" hardcoat consists of .001" penetration and .001" added to the original dimension. Therefore, in machining the part, it is essential to allow for the change and to request a specific coating thickness on blueprints and/or purchase orders.

3. **MASKING-** It may be necessary to exclude (or mask) the coating from certain areas of a part. If so, areas to be masked (threaded hole, bored holes, ground points, etc.) should be clearly specified.

In designing for hardcoat, remember that masking is a hand operation which often, but not always means added total cost. For instance, even if Hardcoat is only required on one area of a part, it is usually much less expensive to permit the part to be coated all over if at all possible. On the other hand, it is usually less expensive to tap holes to a standard size and mask them rather than use oversize taps.

4. **RACKING-** Firm electrical and mechanical "contact" must be made with every part to be Hardcoated. That is, each part must be "racked". Proper racking is a key to economical and effective processing of parts. Since each rack contact point leaves a small void in the coating, it is essential that such contacts be made in non-critical area. Any guidance which can be provided as to where best to rack the part will aid in proper processing.

Before designing a part for Hardcoat, if you have any questions as to how to handle your specific part, please give us a call. We will be glad to advise by telephone or make a personal visit.

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ALUMINUM ALLOYS MOST OFTEN USED WITH THE HARDCOAT PROCESS

Hardcoat is recommended for use with virtually all aluminum alloys.
This information describes the more commonly used alloys.

IMPORTANT: Be sure to remember that the coating thicknesses mentioned. Below are 50% buildup and 50% penetration. In other words, a .002" coating will buildup only .001" per side and not .002" as in plating and similar coatings. While coatings may vary from a few "tenths" to .008" depending on engineering requirements, the standard coating is .002".

WROUGHT ALLOYS

1100 Series – Most common: 1100 only. Bronze gray in color at .002"; alloy is soft and not particularly good for machining. Maximum practical coating thickness 0025"; .003" possible.

2000 Series – Most common: 2014, 2017, 2024, 2618 (forgings). Avoid sharp corners, particularly on 2011-2017; gray-black at .002" to blue-gray at .004"- .005". Excellent machining characteristics. Maximum practical coating .004"; .006" possible for salvage though not as hard as less heavy coats.

3000 Series – Most common: 3003. Gray-black in color at .002". Good for dye work and machining. Maximum coating .002".

4000 Series – Not commonly used.

5000 Series – Most common: 5005, 5052; 5005 best for dye work; 5052 not good for dye work, except black. Both have good machining characteristics. Maximum practical coating .004". 5052 has excellent dielectric when coated to .004".

6000 Series – Most common: 6061, 6063. Almost black at .002", 6061 forms excellent hardcoat for grinding, lapping, honing. Excellent dimensional stability, though a little "stringy" to machine. 6063 used for extrusion. Maximum practical coating .0025". Maximum .003".

7000 Series – Most Common: 7075. Blue-gray at .002". High strength alloy. Not good for grinding and laping; tends to be "checky". Maximum practical coating .004"; maximum for salvage .008".

8000 Series – Not commonly used.

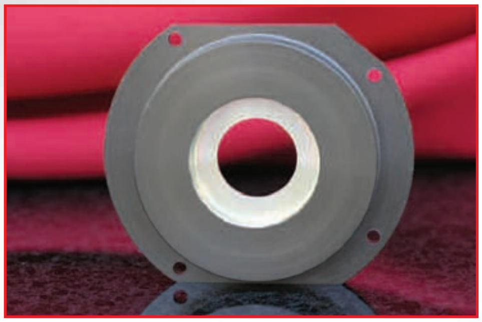
INGOT

Sandcast Alloys – Most common: 319, 355, 356 (also 40E, Ternalloy, Tenzalloy and variety of proprietary alloys). 356T6 is used most often. Grinds and polishes very well. Porosity can cause apparentpits its in coating. Hardcoat will not fill in pores. Maximum practical coating .0044". Salvage .006"

Most common: 218, 360, 380. Only 218 produces hardcoat comparable to that on wrought or sandcast. 218 is difficult to die cast. Maximum .0025". 360, 380 maximum about .001". Color is black, but is not as wear resistant as 218.

Reason for difference in coating quality in die castings is that 218 is 9.4% alloying elements of which the principal one is magnesium. Magnesium is not detrimental to hardcoat and, in fact, these are some high magnesium proprietary sandcasting alloys (such as Almag 35) which hardcoat very rapidly and well. 360 and 380, however, are 11.60% and 13.80% alloying elements respectively, and the principal elements are silicon and copper. Both, but principally silicon, are detrimental to a good hardcoat.

NOTE: Hardcoat may be ground, honed, or lapped, but it is much too hard for conventional machining.



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TO OUR PROSPECTIVE CUSTOMERS

We would like to introduce our company A.M. Metal Finishing, Inc. that has been a premier finishing supplier to Florida industry for over 20 years.

A.M. Metal Finishing, Inc. specializes in anodizing, color anodizing, hardcoat to mil spec, powder coating, teflon coating, and we also offer several other finishing processes such as electropolishing, chromate conversion, passivation, salt spray testing, selective masking and more. We also offer NCP Iridite and are RoHS compliant.

We are an approved vendor for many industrial, commercial and aerospace/defense companies such as Lockheed Martin, Boeing, Westinghouse and more. Our processes conform to military specifications, are cost efficient and can provide quick turn-a-round.

We would be pleased to discuss your finishing needs with you. Call us today toll free at 1-888-663-6136. Thank you.

Yours truly,
Rick Hunter, CEF
President/General Manager

YOUR SOLUTION TO METAL FINISHING!

- Electropolishing
- Color Anodizing
- Hardcoat Anodizing
- Chromate Conversion
- High Volume Anodizing
- Passivation & Turco
- Salt Spray & Humidity Testing
- Powder Coating
- PTFE & Nylon Coating
- Abrasive Blasting

APPROVED VENDOR LIST

- Lockheed Martin
- Boeing Co.
- McDonnell Douglas
- Litton Laser
- Northrup Grumman
- Westinghouse Electric
- NASA
- General Kinetics
- Aircraft Products
- Crestview Aerospace
- Dussault Falcon Jet Corporation
- Kaiser Technologies
- Walt Disney Co.

Note: This is a partial list only. We have vendor approvals for over 60 Companies.

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Ultralon®
Whitford Xylan®
Xylar®
Sandstrom Products Co.®

BENEFITS

Non-stick
Low coefficient of friction
Non wetting
Corrosion resistance
High temperature resistance
Chemical resistance
Unique electrical properties
Cryogenic stability
FDA compliant

APPLICATION

In most cases substrates are prepared for coating by degreasing and grit blasting. Coatings are then applied with either conventional spray guns, electrostatic powder equipment or fluidized beds. The coated products are then heat cured in carefully monitored custom ovens.

Specifications

We are experienced and knowledgeable in the application of coatings for military, aerospace, waterworks and industrial applications. We can certify to most company and military specifications.

TECHNICAL KNOWLEDGE

If you have a new application we can help you select the best coating for your product. If you have an existing application we can select an improved coating, if desired, and provide you outstanding quality and service.

ON TIME DELIVERY

We recognize the need to get coated products back to our customer FAST! Most parts are finished within 3-5 business days after we received them. Do you have an expedite delivery requirement? Let us know, we can accommodate your request. Nobody beats our turn-a-round and we do it without compromising quality.

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RECOMMENDATIONS FOR GRINDING AND FINISHING HARDCOAT ALUMINUM

I. GENERAL

There are many abrasive wheels and compounds suitable for finishing Hardcoat to achieve critical dimensional tolerances or very fine finishes. The recommendations below will more than meet most requirements.

II. GRINDING

A. Surface Grinding- Norton Crystolon (silicon carbide) abrasive (or equal) is most satisfactory. Grit sizes of 80 to 120 will give surface finishes of 8 to 2 micro-inch. Soft wheels in H, I & J grades are preferable for fast stock removal and there is less danger of burning or cracking the work. Typical wheel numbers are 39C60-J8VK for finishes of 6 to 10 and 39C120-H8VK for finishes of 2 to 3 micro-inches.

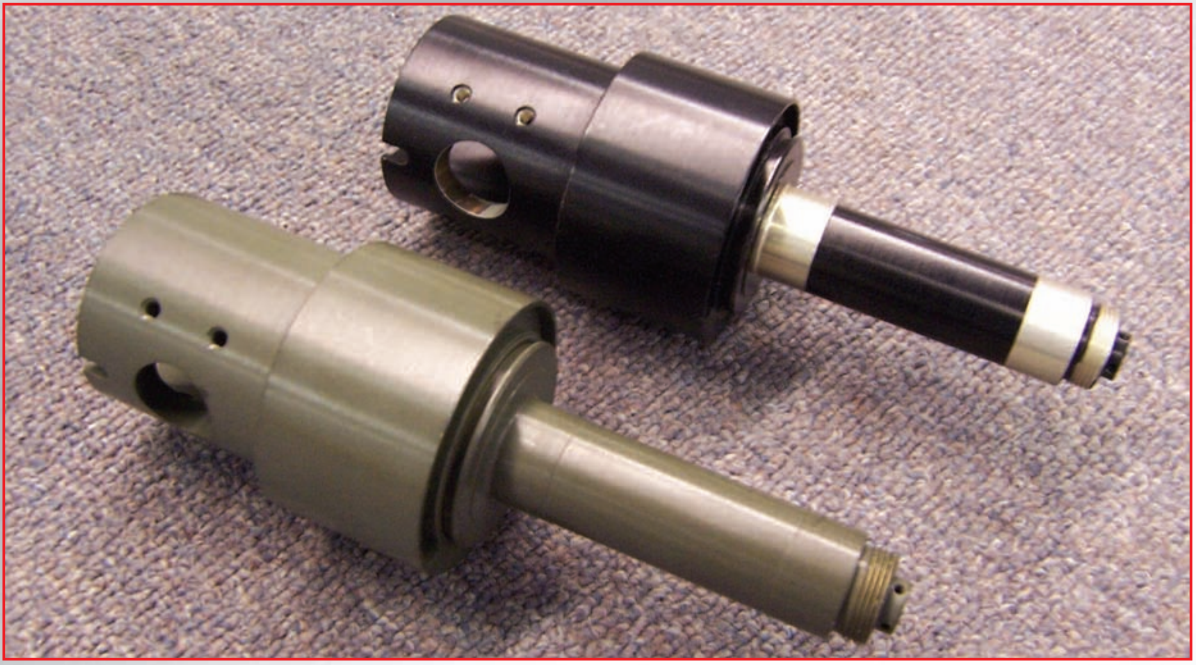
B. Cylindrical Grinding- Best done with a specification of 39C120-J8VK. This finer grit wheel will be free cutting and yet capable of producing very fine finishes.

C. Internal Grinding- A fine grit wheel such as (Norton) 39C100-J8VK produces best results

D. Coolants- In general, grinding should be done wet using a water coolant and a good medium priced soluble oil mixed approximately 100 to 1. In one instance, Cincinnati "Cimplus" mixed 200 to 1 has been highly successful.

III. Polishing or Lapping

A. Recommended Abrasives- Norbide (boron carbide) abrasive grain (or equal) mixed with a carrier of heavy oil or petroleum jelly will give fastest and best results. Use with polishing sticks or brushes is recommended. Grit size range should be 400 to 1200, depending on the finish requires.



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- Abrasive Blasting
- Textures
- Polyurethane
- Hybrid
- Veins
- Chem.-Film

APPLICATION

- Aerospace
- Defense
- Food Processing
- Electronics
- Architectural
- Medical
- Furniture
- Motorcycles
- Automotive
- Marine
- Sports & RV
- Industrial

BENEFITS

- Functional
- Decorative
- Abrasion & Corrosion Resistant
- Smooth or textured finishes
- Resists cracking Peeling and marring
- High or Low Gloss
- Environment friendly.
- Wide Spectrum of Colors
- Color Matching

SPECIFICATIONS

- Military Specifications
- USDA-FDA-ASTM Specifications
- Prototype Runs
- Parts up to 20' lengths
- High Volume Runs

TECHNICAL KNOWLEDGE

If you have a new application we can help you select the best coating for your product. If you have an existing application we can select an improved coating, if desired, and provide you outstanding quality and service.

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PASSIVATION OF STAINLESS STEEL

The conversation usually begins like this: "Hey, this is Joe from Joe's Machine Shop. We have a job in here and the customer wants us to have some kind of passivate coating something or other. Do you guys do that? How thick is that stuff? Is that like plating, paint or what? What color is it? How much tolerance should I allow for it?" The opening statement usually ends with a phrase like; "I don't even know why they need it. What is the point of using stainless steel if you are going to put some kind of coating on it anyway?"

Joe is not the exception. Many machine shops, purchasing agents and engineers are somewhat in the dark when it comes to the relationship between corrosion resistant (stainless) steel and chemical passivation. Even among the finishing community, there is some disagreement about the theory behind the process of chemical passivation. Some believe it is effective because it is a cleaning process. Others credit the enhanced corrosion resistance properties to the thin, transparent oxide film resulting from chemical passivation. Regardless, the bottom line is that it works. Verification tests, including copper sulfate immersion, and accelerated corrosion tests, such as salt spray, high humidity and water immersion, undisputedly confirm the effectiveness of chemical passivation. Advanced material engineers in aerospace, electronics, medical and similar passivation for years. The applications demand the maximum performance from components manufactured from-corrosion-resistant steels, and they realize that passivation is one of the most effective methods of achieving these results.

WHAT IS PASSIVATION?

According to ASTM A380, passivation is "The removal of exogenous iron or iron compounds from the surface of stainless steel by means of a chemical dissolution, most typically by a treatment with an acid solution that will remove the surface contamination, but will not significantly affect the stainless steel itself." In addition, it also describes passivation as "The chemical treatment of stainless steel with a mild oxidant, such as a nitric acid solution, for the purpose of enhancing the spontaneous formation of the protective passive film."

In lay terms, the passivation process removes "free iron" contamination left behind on the surface of the stainless steel from machining and fabricating. These contaminants are potential corrosion sites ultimately result in deterioration of the component if not removed. In addition, the passivation process facilitates the formation of a thin, transparent oxide film that protects the stainless steel from selective oxidation (corrosion). So what is passivation? Is it cleaning? Is it protective coating? It is a combination of both?

How is passivation performed? The process typically begins with a thorough cleaning cycle. It removes oils, greases, forming compounds, lubricants, coolants, cutting fluids and other undesirable organic and metallic residue left behind because of fabrication and machining processes. General degreasing and cleaning can be accomplished many ways, including vapor degreasing . solvent cleaning and alkaline soaking.

After removing organic and metallic residues, the parts are placed into the appropriate passivation solution. Although there, are many variations of passivation solutions, the overwhelming choice is still the nitric-acid-based solutions. Recently, there has been substantial research performed to develop alternative processes and solutions that are more environmentally friendly, yet equally effective. Although alternative solutions containing citric acid and other types of proprietary chemistry are available, they have not been as widely accepted commercially as nitric-acid-based solutions.

The three major variables that must be considered and controlled for the passivation process selection are time, temperature and concentration. Typical immersion times are between 20 min and two hours. Typical bath temperatures range between room temperature and 160° F. Nitric acid concentration in the 20% to 50% by volume range is generally specified. Many specifications include the use of sodium dichromate in the passivation solution or as a post passivation rinse to aid in the formation of a chromic oxide film. Careful solution control, including water purity, ppm of metallic impurities and chemical maintenance, are crucial for success.

The type of stainless steel determines the most effective passivation process. Bath selection (time, temperature and concentration) is a function of the type of alloy processed. A thorough knowledge of the material types and passivation processes is paramount to achieving the desired results. Conversely, improper bath and process selection and/or process control will produce unacceptable results. In extreme cases, this can lead to catastrophic failure, including extreme pitting, etching and/or total dissolution of the entire component.

continues on page 2

PASSIVATION OF STAINLESS STEEL, CONT.

continued from page 1

Equipment and precautions. Passivation should only be performed by trained, experienced technicians familiar with the potential hazards associated with the science. Safety practices must be fully understood when handling passivation chemicals. Special boots, gloves, aprons and other safety equipment MUST be used.

Tanks, heaters and ventilation, as well as baskets and racks must be appropriately engineered to perform the process. Iron or steel parts or equipment must never be introduced-to the process, or the results can be devastating. Furthermore, in order to comply with EPA requirements, the necessary water and air permits and treatment capabilities must be in place. The days of mom-and-pop shops performing passivation in a stone crock in the back of the shop are gone.

SPECIFICATIONS AND VERIFICATION TESTING

There are a few generally accepted industry specifications available for reference when choosing a passivation process. They offer time, temperature and concentration information and subsequent testing requirements to validate the effectiveness of the process. Many large corporations have developed internal specifications to control their unique requirements regarding passivation and verification testing. Regardless of the situation, it is usually prudent to reference a proven procedure when requesting passivation. By referencing a specification, you do not have to reinvent the wheel. By taking advantage of the experiences of others, both successes and failures, you can eliminate much of the guesswork that would otherwise accompany a new process.

Although recently canceled, the most commonly referenced industry specifications regarding passivation are Federal Specification QQ-P-35C, which is now superseded by ASTM A-967 and ASTM A-380. All are well-written, well-defined documents that provide guidance on the entire process, from manufacturing to final testing requirements. If you are not sure what you need, they can be referenced in full or selectively. The test requirements can be used or waived, depending on the individual situation.

One of the most commonly specified verification tests is the copper sulfate test. Passivated parts are immersed in a copper sulfate solution for six minutes, rinsed and visually examined. Any popper (pink) color indicates the presence of free iron and the test is considered unacceptable.

Other validation tests include a two-hour salt spray or 24-hour high humidity test; these tests are performed by placing passivated parts in a highly controlled chamber that creates an accelerated corrosive environment. After subjecting the test pieces to the corrosive atmosphere for the prescribed exposure periods, the parts are removed and evaluated. Although results can be somewhat subjective, ASTM B-1 17 is an excellent reference in determining acceptability. It is important to note that each of the test methods mentioned have different advantages and limitations. Care should be taken to select the appropriate test methods based on alloy type and end-use environment.

MACHINING AND HEAT TREATING TECHNIQUES

Perhaps the most overlooked variable in the entire passivation equation is the negative impact of poor machining and heat treating practices. All too often, cross contamination introduced during manufacturing and/or thermal processes leads to unacceptable test results. The following practices will reduce cross contamination during manufacturing and increase the chances of successful passivation and tests results.

- Never use grinding wheels, sanding materials or wire brushes made of iron, iron oxide, steel, zinc or other undesirable materials that may cause contamination of the stainless-steel surface.

- The use of carbide or other non-metallic tooling is recommended.

- Grinding wheels, sanding wheels and wire brushes that have been previously used on other metals should not be used on stainless steel.

- Use only clean, unused abrasives such as glass beads or iron-free silica or alumina sand for abrasive blasting. Never use steel shot, grit or abrasives that have been used to blast other materials.

- Thorough cleaning prior to any thermal processing is critical. Stress relieving, annealing, drawing or other hot-forming processes can actually draw surface contaminants deeper into the substrate, making them almost impossible to remove during passivation.

- Care should be taken during all thermal processes to avoid the formation of oxides. Passivation is not designed to remove discoloration and will note penetrate heavy oxide layers. In extreme situations, additional pickling and descaling operations are required prior to passivation to remove the discoloration. Controlled atmosphere ovens are highly recommended for all thermal processes to reduce airborne contamination and prevent oxides from developing.

So how do you get the performance you have paid for from high-dollar stainless steel alloys? It boils down to a basic understanding that the passivation process is both an art and a science, and that machining, fabricating and heat treating practices can substantially affect the corrosion resistance of the component. Passivation will enhance the corrosion resistance of stainless steels, but to realize the maximum performance from these high-tech alloys, all parties involved with manufacturing must understand their responsibility in maintaining the integrity of the material throughout the process.

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ANODIZING REFERENCE GUIDE

MIL SPEC 8625 F

Type I A	**Thickness**
Conventional coatings produced from chromic acid bath	0.5μ-7.6μ
Type I B	
Low voltage chromic acid anodizing (20 volts) Used for 7xxx series alloys	0.5μ-7.6μ
Type II	
Conventional coatings produced from sulfuric acid bath	1.8μ-25.4μ
Type III	
Hard coat (Uniform anodic coatings)	12.7μ-115μ
Class 1 Non dyed **Class 2** Dyed	

TEST METHODS FOR TYPE II ANODIZED ALUMINUM

Oxide Coating Thickness

ASTM B 244-79
ASTM B 487-85

	Min Thickness
Class I	18 Microns
Class II	10 Microns

Oxide Coating Weight and Apparent Density

ASTM B 137-89

	Min Weight	Min Density
Class I	4.18 mg/cm2	2.32 g/cm3
Class II	2.40 mg/cm2	2.32 g/cm3

Corrosion Resistance

ASTM B 117-90

	Min Hours	Max Spots
Class I	3000	15
Class II	1000	15

Seal Quality

ASTM B 136-77
ASTM B 680-80
ISO 3210

	Max Weight Loss
Class I	40 mg/dm2
Class II	40 mg/dm2

Adopted from AMAA 611

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ANODIZING REFERENCE GUIDE, CONT.

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ALUMINUM ALLOY REFERENCE FOR ANODIZING

Series (AA)*	Alloying Constituants	Metal Properties	Coating Properties	Uses	A.Q.** Types	Non-A.Q.** Types
1xxx	None	soft conductive	clear bright	cans architectural	none	1100, 1175
Finishing advice: care should be taken when racking this soft material; good for bright coatings; susceptible to etch staining						
2xxx	Copper	very strong hard low elongation	yellow poor protection	aircraft mechanical	none	2011, 2017 2219, 2224
Finishing advice: since copper content is >2%, these produce yellow, poor weather-resistant coatings; don't mix with other alloys on load						
3xxx	Manganese	strong small grains	grayish-brown	cans architectural lighting	none	3003, 3004
Finishing advice: difficult to match sheet-to-sheet (varying degrees of gray/brown); used extensively for lighting						
4xxx	Silicon	strong fluid	dark gray	architectural welding wire	none	4043, 4343
Finishing advice: produce heavy black smut which is hard to remove; 4043 & 4543 used for architectural dark gray finishes in past years						
5xxx	Magnesium	strong ductile fluid	clear good protection	architectural welding wire lighting	5005, 5657	5052, 5252
Finishing advice: for 5005-keep silicon<0.1% and magnesium between 0.7% and 0.9%; watch for oxide streaks; 5005 used extensively for architectural						
6xxx	Magnesium & Silicon	strong ductile	clear good protection	architectural structural	6063, 6463	6061, 6101
Finishing advice: matte-iron>0.2%; bright-iron<0.1%; 6063 best match for 5005; 6463 best for chemical brightening;						
7xxx	Zinc	very strong	clear good protection	automotive	none	7029, 7046 7075
Finishing advice: zinc over 5% will produce brown tinted coating; watch zinc in effluent stream; good for bright coatings						

* AA - Aluminum Association
** A.Q. - Anodizing Quality - material suitable for architectural anodizing applications

TYPE I "CHROMIC ACID"

Color will vary from clear to dark gray depending on alloy. Copper bearing alloys only yield gray colors. Not as readily dyed as sulfuric anodize due to thinness of coating.

New salt spray requirement is 336 hours (5% solution per method 811 or FED-STD-No. 151).

Type I

Chromic acid anodized coating. This process is used principally for the treatment of aircraft parts. An example is the Bengough-Stewart process where a 30 - 50 g/l chromic acid bath is maintained at 100° F and the voltage is gradually raised to 50V. Adjustments are made for high copper, zinc, and silicon alloys. Coating weights must be greater than 200 mg/ft2. Criteria for corrosion resistance, paint adhesion, and paint adhesion testing must be specified.

Type IB

Low voltage (22)2V) chromic acid anodized coating. Typically associated with higher temperature, more concentrated chromic acid electrolytes. Coating weights must be greater than 200 mg/ft2. Criteria for corrosion resistance, paint adhesion, and paint adhesion testing must be specified.

Type IC

Anodized coating produced in a non-chromic acid electrolyte. As with other Type I coating processes, the treatment is designed to impart corrosion resistance, paint adhesion, and/or fatigue resistance to an aluminum part. Coating weights must fall between 200 - 700 mg/ft2. Criteria for corrosion resistance, paint adhesion, and paint adhesion testing must be specified.

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ANODIZING REFERENCE GUIDE, CONT.

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TYPE II "SULFURIC ACID"

MECHANICAL FINISHING	A.A.	COMMON	DESCRIPTION	EXAMPLES OF FINISHING METHODS
As Fabricated	M-10		Unspecified	
	M-12		Nonspecular as fabricated	No particular reflectiveness
Buffed	M-21		Smooth specular	Polished first with coarser than 320 grit, followed by 320 grit, then buffed with Alum oxide.
	M-22		Specular	Buffed with Alum oxide compound.
Directional Textured	M-31		Fine satin	Sanded with 320-400 grit Alum oxide.
	M-32		Medium satin	Sanded with 180-220 grit Alum oxide.
	M-33		Coarse satin	Sanded with 80-100 grit Alum oxide.
	M-35		Brushed	Brushed with stainless steel wire brush.
CHEMICAL FINISHING				
Nonetched Cleaning	C-11		Degreased	Organic solvent treated.
	C-12		Inhibited chemical cleaned	Soap cleaner only.
Etched	C-22	R-1	Medium matte	Sodium hydroxide (caustic soda) 30-45 gr/li @ 60-65° C for 5 min.
Brightened	C-31	R-5	Highly specular	Chemical bright dip solution of the proprietary phosphoric-nitric acid type, or electropolishing.
	C-32		Diffuse bright	Etched finish C-22 followed by Brightened finish C-31.
ANODIC COATING				
General	A-11		Prep for other applied coatings.	15% Sulfuric acid @ 20° C, 12 amps/sq ft. for 10 min. Sometimes not sealed.
Decorative	A-21		Clear coating 2.5µ - 7.5µ	15% Sulfuric acid @ 20° C, 12 amps/sq ft.
Less than 10µ	A-211	200	Clear coating min. 2.5	15% Sulfuric acid @ 20° C, 12 amps/sq ft. for 10 min.
	A-212	201	Clear coating min. 5µ	15% Sulfuric acid @ 20° C, 12 amps/sq ft. for 15 min.
	1-213	202	Clear coating min. 7.5µ mil	15% Sulfuric acid @ 20° C, 12 amps/sq ft. for 20 min.
	A-23		Coating with impregnated color	15% Sulfuric acid @ 20° C, 12 amps/sq ft., followed by dyeing with organic or inorganic colors.
	A-24		Coating with electrolytically deposited color	15% Sulfuric acid @ 20° C, 12 amps/sq ft. , deposited color followed by deposition of inorganic metallic salts.
Architectural Class 2	A-31	204	Clear coating 10µ - 18µ	15% Sulfuric acid @ 20° C, 12 amps/sq ft.
10µ-18µ	A-33		Coating with impregnated color	15% Sulfuric acid @ 20° C, 12 amps/sq ft. for 30 min., followed by dyeing withorganic or inorganic colors.
	A-34		Coating with electrolytically deposited color	15% Sulfuric acid @ 20° C, 12 amps/sq ft. deposited color for 30 min., followed by deposition of inorganic metallic salts.
Architectural Class 1	A-41	215	Clear coating min. 18µ	15% Sulfuric acid @ 20° C, 12 amps/sq ft.
18µ and more	A-43		Coating with impregnated color	15% Sulfuric acid @ 20° C, 12 amps/sq ft. for 60 min., followed by dyeing with organic or inorganic colors.
	A-44		Coating with electrolytically deposited color	15% Sulfuric acid @ 20° C, 12 amps/sq ft. deposited color for 60 min., followed by deposition of inorganic metallic salts.

Data derived from "Designation System for Aluminum Finishes" (DAF45), published by *The Aluminum Association.*

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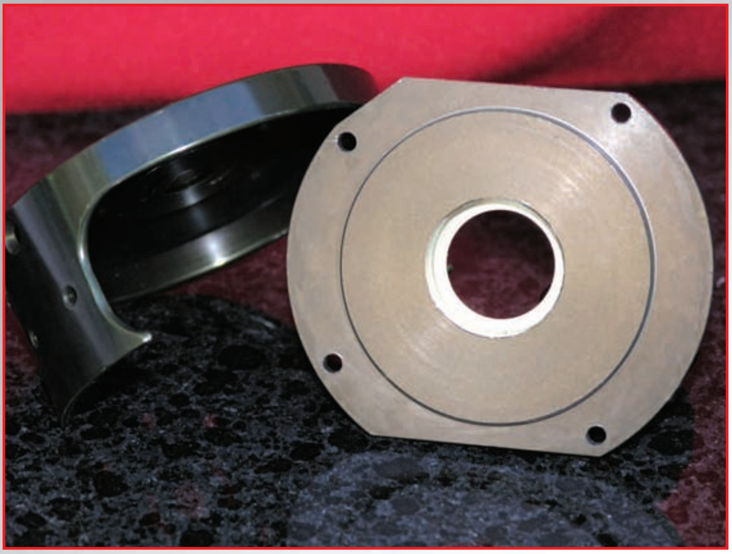
TYPE III "HARD COATING"

Color will vary from light tan to black depending on alloy and thickness. Color overtones listed below may vary with the use of additives and/or the process. Can be dyed in darker colors depending on thickness. Coating PENETRATES base metal as much as builds up on the surface. The term THICKNESS includes both the buildup and penetration. Provides very hard ceramic type coating. Abrasion resistance will vary with alloy and thickness of coating. Good dielectric properties. Corrosion resistance is good, but recommend sealing in 5% dichromate solution where increased corrosion resistance is required. Where extreme abrasion resistance is required do not seal as some softening is encountered.

TYPE III ANODIZE THICKNESS GUIDE

ALLOY	MAJOR CONSTITUENT	MAXIMUM THICKNESS* (IN)	COLOR*** OVERTONES
1100	99.5% pure Alum.	.003	**Gray/Green
2011	Copper	Not recommended	
2014	Copper	.001	Bronze
2017	Copper	.001	Bronze
2024	Copper	.0015	Bronze
3003	Manganese	.002	Gray
4032	Silicon	.0012	Gray
5005	Magnesium	.0035	Gray/Brown
5052	Magnesium	.0035	Gray/Brown
5083	Magnesium	.0035	Gray/Brown
6061	Mag/Silicon	.003	Dark Gray
6063	Mag/Silicon	.004	Green
6105	Mag/Silicon	.0035	Gray/Green
6262	Mag/Silicon	.0025	Gray
6463	Mag/Silicon	.003	Gray
7075	Zinc	.004	Bronze
355	Silicon	.0035	Gray
356	Silicon	.0035	Gray
357	Silicon	.0035	Gray
360	Silicon	.0005	Gray
380	Silicon	.0005	Gray
319	Silicon	.0025	Light Gray
MIC-6	Silicon	.0035	Dark Gray

50% Penetration and 50% Buildup per Surface
* Generally Accepted
** Over .0025" Thick
*** May vary



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METAL FINISHING

ALUMINUM ANODIZING

ALUMINUM ANODIZING is an electrochemical method of converting aluminum into aluminum oxide (Al_2O_3) at the surface of the item being coated. It is accomplished by making the work piece the anode while suspended in a suitable electrolytic cell. Although several metals can be anodized, including aluminum, titanium, and magnesium, only aluminum anodizing has found widespread use in industry.

Because a wide variety of coating properties can be produced through variations in the process, anodizing is used in almost every industry in which aluminum can be used. The broadest classification of types of anodize is according to the acid electrolyte used. Various acids have been used to produce anodic coatings, but the most common ones in current use are sulfuric (H_2SO_4) and chromic (CrO_3) acids. Although CrO_3 anodizing is standardized, there are two main types of H_2SO_4 anodizing. The first is a room-temperature H_2SO_4 process termed conventional anodizing. In addition to CrO_3 conventional, and hardcoat anodizing, a process known as sealing can be used to enhance certain characteristics. A number of standard tests are used in the industry to test the quality and characteristics of anodic coatings.

The three common types of anodize described above are usually controlled and described through the use of military specification MIL-A-8625 (Table 1). It has become standard in the industry to describe anodic coatings with the type and class nomenclature outlined in this specification.

The articles "Corrosion of Magnesium and Magnesium Alloys" and "Corrosion of Aluminum and Aluminum Alloys" in this Volume contain information on the corrosion resistance of anodized magnesium alloys and aluminum alloys. More information on the anodizing process for aluminum is available in the article "Cleaning and Finishing of Aluminum and Aluminum Alloys" in Volume 5 of the 9th Edition of *Metals Handbook*.

CHROMIC ANODIZE

Chromic anodize (type I; see Table 1) is formed by immersing the workpiece in an aqueous solution of CrO_3. Current is then applied, with the workpiece being positively charged. Typical operating parameters for the CrO_3 anodizing process are:

- *Electrolyte concentration: 50 to 100 g/L CrO3*
- *Temperature: 37 + 5 0C (100 + 9 0F)*
- *Time in bath: 40 to 60 min*
- *Voltage: Increase from 0 to 40 V in 10 Min; hold at 40 V for balance of time*
- *Current density: 0.15 to 0.30 A/dm2 (1.4 to 4.3 A/ft2)*

Chromic Anodized Coatings. The CrO_3 anodizing process produces a coating that is nominally 2 µm (0.08 mils) thick. It is relatively soft and susceptible to damage through abrasion or handling. The color of the class 1 coating ranges from clear to gray, depending on whether the coating is sealed and on the alloy coated. The coating can be dyed to produce a class 2 coating; however, this is not generally done, because the coating is thin and does not retain the dye color well. About two-thirds of the coating thickness penetrates the base metal; one-third of the coating builds above the original base metal dimension. Thus, for a coating thickness of 2 µm (0.08 mils) per side, the dimensional change of the workpiece would be 0.7 µm (0.028 mils) per side.

Although the industry has adopted the penetration/buildup terminology, the terms are somewhat misleading. Actually, when the aluminum is converted to Al_2O_3 it takes up more space- approximately 133% of the space previously occupied by the aluminum converted. The penetration/buildup terms are used only as a convenience in predicting dimensional change in a coated article. The corrosion resistance of this coating is very good. The coating will pass in excess of 336 h in 5% salt (NaCl) spray per ASTM B 117.

Advantages. Although CrO_3 anodizing is the least used of the three types of anodize, it has several advantages that make its use desirable. First, because CrO_3 is much less aggressive toward aluminum than H_2SO_4, it should be used whenever part design is such that rinsing is difficult. Difficult rinsing designs would include welded assemblies,

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TABLE 1 CLASSIFICATION OF ANODIZE ACCORDING TO MIL-A-8625

Type	Class	Description	Dye	Seal	Thickness µm	Thickness mils
I	I	CrO3anodize	No	Yes	1.3-2.5	0.05-0.1
I	2	CrO3anodize,dyed	Yes	Yes	1.3-2.5	0.05-0.1
II	1	H2SO4 anodize	No	Yes	7.5-15	0.3-0.6
II	2	H2SO4 anodize, dyed	Yes	Yes	7.5-15	0.3-0.6
III	1	Hardcoat anodize	No	No	46-56	1.8-2.2
III	2	Hardcoat anodize, dyed	Yes	Yes	46-56	1.8-2.2

continued from page 1

riveted assemblies, and porous castings. Second, a typical CrO_3 anodize buildup is 0.7 µm (0.028 mils) per side with good repeatability. Therefore, it is very good coating to use when it is necessary to coat a precise dimension to size. Third, because CrO_3 anodize produces the least reduction in fatigue strength of the three coatings, it should be used where fatigue strength is a critical factor. Fourth, the color of CrO_3 anodize will change with different alloy compositions and heat-treat conditions; this makes it useful as a test of the homogeneity of structural components. Lastly, when properly applied, CrO_3 anodize can be used as a mask for subsequent hardcoat anodize operations.

Suitable Alloys. Most alloys can be successfully coated by the CrO_3 process. Exceptions are high-silicon die-cast alloys and high-copper alloys. The rule for suitability is that any alloy containing more than 5% Cu, 7% Si, or total alloying elements of 7.5% should not be coated by this process.

Relative Costs. Chromic anodize costs more than H_2SO_4 but less than hardcoat anodize.

SULFURIC ANODIZE

Sulfuric anodize, or type II anodize, is formed by immersing the item in an aqueous solution of H_2SO_4. Current is then applied, and the workpiece is positively charged. Typical operating parameters for the H_2SO_4 anodizing process are:

- *Electrolyte concentration: 15% H2SO4*
- *Temperature: 21+ 1 oC (70 + 2 oF)*
- *Time in bath: 30 to 60 min*
- *Voltage: 15 to 22 V, depending on the alloy*
- *Current density: 1 to 2 A/dm2 (9.3 to 18.6 A/ft2)*

Sulfuric Anodized Coatings. This process produces a coating that is normally 8 µm (0.31 mils) in minimum thickness. Although harder than type I coatings, H_2SO_4 anodize may still be damaged by moderate handling or abrasion. The color of the class I coating is yellow-green because of the preferred sealing method of immersion in sodium dichromate ($Na_2Cr_2O_7$). Clear coatings can also be produced by sealing in hot water. Clear coatings should be specified by the notation "class I, clear." This coating can also be dyed to produce a class 2 coating. This type of anodize produces the most pleasing colors of the three anodizing methods. Dyed H_2SO_4 anodize coatings have deep colors with good repeatability. Like CrO_3 anodize, H_2SO_4 anodize coatings penetrate the base metal for two-thirds of their thickness and build above the original base metal dimension for one-third the total thickness. As with all types of anodize, the corrosion resistance of H_2SO_4 anodize is very good; it has an ASTM B 117 salt spray resistance of at least 336 h.

Advantages. Sulfuric anodize is the most widely used type of anodize and has many desirable benefits. First, because it has a fairly hard surface, it can be used in situations that require light-to-moderate wear resistance. Applications include lubricated sliding assemblies and items subject to handling wear, such as front panels. Second, because it is the most aesthetically pleasing type of anodize, it should be used where final appearance is important. It can be dyed almost any color and produces deep, rich shades that make the item appear to be made of a material bearing a color throughout, rather than an applied coating. Lastly, because corrosion resistance is needed and the specialized benefits of the other two anodize types are not required.

Suitable Alloys. With the exception of high-silicon die-cast alloys, all alloys can be successfully coated with H_2SO_4 anodize. Clarity and depth of color of the anodize increase with the purity of the alloy. Therefore, alloys should be chosen for maximum purity consistent with the physical requirements needed in the item.

Relative Cost. Sulfuric anodize is the least costly and most widely available type of anodize.

HARDCOAT ANODIZE

Hardcoat anodize, or type III anodize, is formed by immersing the item in an aqueous solution of H_2SO_4. Current is then applied, with the workpiece being the anode. The operation parameters for a generic hardcoat anodize process are:

- *Electrolyte concentration: 22 to 24% H2SO4*
- *Temperature: 0 + 1 oC (32 + 2 oF)*
- *Time in Bath: 20 to 120 min*
- *Voltage: constantly increased to maintain current density at 2.5 to 4.0 A/dm2 (23.2 to 27 A/ft2)*

Hardcoat Anodize Coatings. This process produces a coating that is normally 50 µm (2 mils) thick, although other thicknesses can be specified. The coating is extremely hard. It is described as file hard (equal to about 60 to 70 HRC). The color of the class I coating ranges from gray to bronze to almost black, depending on the alloy coated, the coating thickness, and the electrolyte temperature. The coating can be dyed to produce a class 2 coating. Because thick coatings are naturally very dark, only colors darker than natural are possible. Generally, this limits the dying of hardcoat to black in common processes. If a more extensive color choice is required, there are several proprietary hardcoat processes available to accomplish this.

Hardcoat penetrates the base metal for one-half of its thickness and builds above the original base metal dimension for one-half of its thickness. Thus, for a thickness of 50 µm (2 mils) per side, the dimensional change of the workpiece would be 25 µm (1mil) per side. Commercially available coating thickness tolerances are the greater of $\pm$ 5 µm or $\pm$ 10% of the total targeted thickness. The corrosion resistance of the unsealed class I coating is very good and comparable to the other types of anodize. When the hardcoat anodize is sealed, as in a class 2 coating, it becomes the most corrosion-resistant type of anodize.

Advantages. Hardcoat anodize, because its variety of desirable properties, has found widespread use in manufactured products. First, because of its extreme hardness, it is used in situations in which wear resistance is required. Applications include valve/piston assemblies, drive belt pulleys, tool holders and fixtures, and many other items requiring wear resistance.

Second, because of its excellent resistance to corrosion, hardcoat is used on aluminum components in harsh environments. Third, because hardcoat is an excellent electrical resistor, it can be used to insulate heat sinks for direct mounting of electrical or electronic equipment. Also, it is used in welding fixtures where some areas may need to be insulated from work.

Fourth, because hardcoat is a naturally porous substance, it is used in many areas in which the bonding or impregnation of other materials to aluminum is needed. This coating bonds very well with paints and adhesives. Also, it can be impregnated with Teflon (polytetrafluoroethylene or PTFE) and many dry film lubricants to impart lubricating properties to the coating.

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Lastly, because of its desirable properties and also because it produces a buildup of coating, it is widely accepted as a salvage coating to restore worn or improperly machined parts to usable dimensions. Coating thicknesses in excess of 250µm (10 mils) per side are possible on some alloys with certain proprietary hardcoat processes.

Suitable Alloys. Although almost all alloys can be coated, the 6000-series aluminum alloys produce the best hardcoat properties. As with the other anodize types, high-silicon die castings produce the lowest-quality coatings. Also, because the hardcoat process is sensitive to copper, alloys in the 2000-series should be avoided if possible. Alloys containing copper can be hardcoated, but only a relatively few commercial sources have the ability to coat these alloys with reliability.

Relative Costs. Hardcoat anodize is the most expensive type of anodize. It is generally twice the cost of H_2SO_4 anodize and 50% more than CrO_3 anodize.

SEALING OF ANODIZED COATINGS

Because all of the anodic processes produce porous Al_2O_3 coatings, it is often desirable to seal the coating to close these pores and to eliminate the path between the aluminum and the environment. Sealing involves immersing the coating in hot water: this hydrates the Al_2O_3 and causes the coating to swell in order to close the pores. Conventional sealing is generally done at a minimum temperature of 95 ^oC (200 ^oF) for not less than 15 min. There are also several proprietary nickel-base sealing agents available that are said to produce sealing at low temperature through catalytic action. Chromic and sulfuric anodizes are almost always sealed. However, because sealing softens the coating somewhat, hardcoat anodize is usually not sealed unless criteria other than hardness have the maximum importance in the finished coating.

TESTING OF ANODIZED COATINGS

There are six commonly used tests to determine the quality of anodized coatings. These are visual, corrosion resistance, wear resistance, adhesion, thickness, and coating weight. Only a brief overview will be given here; extensive instructions are available in specification MIL-A-8625.

Visual inspection often indicates the overall quality of a coating. The anodic film should be uniform in appearance and free from breaks, scratches, and powdery areas.

Corrosion resistance is most often tested by salt spray. A coated panel is suspended in a salt fog for a period of time (typically 336 h) and then examined for pits and corrosion.

Wear resistance is tested through an abrasive cycle. A test is weighed, abraded for a number of cycles, and weighed again to determine the coating weight lost through the abrasion.

Adhesion is tested by bending a coated panel around a mandrel and checking for delamination.

Thickness is commonly checked by using one of three methods. The first is by metallographic microscope. Second, thickness can be determined by measuring a dimension of the coated part, stripping the coating, and measuring again to determine dimensional change. Third, coatings can be measured using eddy-current instruments.

Coating weight is an indication of the density of the coating in relation to its thickness. Coating weight is determined by weighing a coated panel of known area, stripping the coating, reweighing the panel, and dividing the weight loss by the panel area for the indication of weight loss per unit area.

Table 2 lists standard test methods for anodize. More information on the testing of anodize is available.

STRIPPING OF ANODIZED COATINGS

Stripping a part that has been anodized always results in some loss of dimensions as compared to the original sizes of the part. This is because the aluminum that was consumed to form the coating is removed since it has now become part of the coating. Thus, while a type II coating 7.5 µm (0.3 mils) thick would result in a 2.5-µm (0.1 mil_ increase from original dimensions, stripping would decrease this by at least 7.5 µm (0.3 mils), depending on the precision of the operation.

There are three main methods of stripping, with varying degrees of controllability. Controllability is defined as the ability to remove only the anodize and not damage the aluminum base metal. The least controllable method is by immersion in warm sodium hydroxide (NaOH). This is known as caustic etching. In addition to removing anodize, this process also dissolves aluminum at a fast rate. A more controllable method is by immersion in a H_2SO_4-CrO_3, solution. These solutions are generally classified as deoxidizers. This process will also dissolve aluminum, but at a much slower rate than etching. The most controllable method is by immersing the part to be stripped in a CrO_3-H_2PO_4, solution at a minimum temperature of 95 ^oC (200 ^oF). This solution will dissolve only the coating and will not harm the aluminum.

TABLE 2
ASTM STANDARD TEST METHODS FOR ANODIZED COATINGS

Method	Standard
Coating Thickness	
Eddy Current	B 244
Metallographic	B 487
Light section microscope	B 681
Coating Weight	B 137
Sealing	
Dye stain	B 136
Acid dissolution	B 680
Impedance/admittance	B 457
Voltage breakdown	B 110
Corrosion resistance	
Salt spray	B 117
Copper-accelerated, acetic acid salt spray	B 368
Ford anodized aluminum corrosion test	B 538

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