**EXTRALUM**

# Technical Bulletin.

## Aluminum Profile Anodizing Process.

### Introduction.

The use of aluminum and its alloys1 constitutes a fortunate solution in the fight against corrosion –in front of corrosive environments-, since it has a higher resistance than usual for other metals.

There are three basic properties that explain the wide use of aluminum: low density (light), high mechanical resistance obtained (when the appropriate alloy is used) and high corrosion resistance of pure metal.

This resistance to corrosion, typical of aluminum, is due to the particularity of being an element with a high affinity for oxygen, which causes the metal exposed to air to be covered with a very thin film of natural oxide that protects it from the environment. due to its dielectric and insulating character.

The structure of this aluminum layer is not regular, and its protective power is limited to non-aggressive environments. On the other hand, commercial metal, and its alloys, are more sensitive to corrosion than pure metal, so it is necessary to use suitable protection methods depending on the subsequent application (for which they are used).

The surface of aluminum and its alloys, if exposed unprotected to the elements, develops an ugly gray appearance, which turns black in industrial atmospheres.

Although there are many protection methods, the most widespread is anodizing treatment, due to the quality of the finish and the wide range of applications it has, such as architecture, aeronautics, thermal insulation, among others.

[1] Alloy: It is a homogeneous solid mixture of two or more metals or one or more metals with some non-metallic elements.

Not by chance, the first industrial anodizing process (1923) was developed to protect aluminum plates from seaplanes.

## Obtaining Aluminum.

Aluminum production consists of 3 steps: extraction of bauxite[1], production of alumina[2] and electrolysis[3] of aluminum.

Aluminum is the third most abundant metal on the surface of the earth, approximately 8%. Bauxite is mainly made up of one or more components of aluminum hydroxide, in addition to silica, iron and titanium oxide as the main impurities.

Bauxite must be converted to pure aluminum oxide before it can be converted to aluminum by electrolysis. The aluminum oxide is separated from the other bauxite substances by means of a caustic soda solution, the obtained mixture is filtered to remove all the insoluble particles. Subsequently, the aluminum hydroxide is precipitated from the soda solution, washed and dried, while the soda solution is recycled. After calcination, the final product, aluminum oxide ($Al_2O_3$), is a fine white powder.

The primary aluminum is produced in reduction plants, where the pure aluminum is extracted from the alumina through the Hall-Heroult[4] process. The process of reducing alumina in liquid aluminum is carried out at an average temperature of 650° Celsius in a fluorinated bath and under a high intensity of electric current.

At Extralum the alloys that are extruded are AA6063 and AA6005. These types of alloys acquire specific properties according to the percentage of Magnesium (Mg) and Silicon (Si) present as alloys.

[1] Bauxite: Raw material for the production of aluminum.

[2] Alumina: pure Aluminum Oxide ($Al_2O_3$). Very thin film of natural oxide.

[3] Electrolysis: Word that originates from the electro roots, electricity and lysis, separation. It is the process with which a compound is separated into the elements that make it up, using electricity for this.

[4] Hall-Heroult: Surnames of the two researchers, Charles Hall and Paul Heroult, from Normandy, who created the method by which molten aluminum is collected.

## Industrial Sources of Aluminum.

The main industrial sources of aluminum and its compounds are bauxite and, to a lesser degree, cryolite ($Na_3AlF_6$), alunite ($KAl_3(SO_4)_2(OH)_6$), leucite ($KAlSi_2O_6$) and aluminous shale.

Bauxite rock is primarily a hydrated aluminum oxide, Al2O3H2O, but generally has impurities from iron oxide, phosphorous and titanium compounds. Some of the materials known as bauxite have the composition of diaspore, hydrated aluminum oxide Al2O2 (OH) 2 or Al2O3H2O. The following table shows the forms of the alumina.

| **Oxide** | **Properties** | **Structure** |
|---|---|---|
| $Al_2O_3$ | Amphoteric | Shape □ Corundum inactive, high temperature shape. Oxides ions in compact cubic arrangement with aluminum ions regularly distributed at octahedral sites. The density of the rhombohedron is 3.96<br><br>Shape □ Hexagonal structure whose density is 3.31<br>Form □ Low temperature form, it is more reactive. The randomly arranged metal ions on the octahedral and tetrahedral sites of a cubic spinal. Its density is 3.42 It is transformed at 750°C |

Alumina also exists in the form of gems:

| | |
|---|---|
| White Sapphire | $Al_2O_3$ |
| Ruby | $Al_2O_3$ + traces de $Cr^3$ |
| Blue Sapphire | $Al_2O_3$ + traces de $Fe^2$, $Fe^3$ o $Ti^{4+}$ |

The common form of bauxite is as an earthy, granular, amorphous, or pisolytic mass, with a range of colors that varies from dirty white, greyish, yellow brown, or reddish brown, with an average of 60% alumina compared to 40%. % of kaolin or clay of good quality.

## The Anodizing Process.

Anodizing is an electrolytic process by means of which the natural protective oxide film that appears on the surface of aluminum and its alloys is made thicker. Anode[1] is aluminum and cathode [2] is usually a sheet of aluminum in an electrolytic cell. When the electricity passes, instead of the oxygen being released at the anode as a gas, it combines with the aluminum to form a layer of porous aluminum oxide.

[1] Anode: This is the name given to the positive terminal electrolytic cell.

[2] Cathode: This is the name given to the negative terminal electrolytic cell.

All alloys in aluminum extrusions can be anodized. However, not in all cases the results obtained are as expected.

The anodic layer can vary in both color and density. Also, they can vary depending on the use that will be given. The American Architectural Manufacturing Association (AAMA) applies the following definitions in its specification AAMA 11-92:

| | |
|---|---|
| No rate | 0.1 a 0.3 mils* (6 microns) |
| Arquitectural Class II | 0.4 a 0.7 mils* (10 microns) |
| Arquitectural Class I | 0.7 a 1.0 mils* (18 microns) |

* One mils equals one thousandth of an inch

Unclassified coatings are typically decorative finishes, frequently used in interior applications.

Class II architectural layers are commercial anodic layers used in both interior and exterior applications that receive frequent -regular- maintenance, such as store facades.

Class I Architectural finishes are used for more demanding exterior applications, because greater protection is required.

The profiles to be anodized should be treated as soon as possible after being extruded, preferably within the next 12 hours. During this interval, they should be lightly covered with paper and should be stored in an area where there are no variations in ambient temperature or humidity.

The behavior of the AA6063 alloy when anodizing is very good, allowing, if the case requires it, layers of significant thickness with excellent adhesion and correct stability of the applied colors.

Compared to other alloys with greater mechanical resistance, the AA6063 presents a more homogeneous tonality and an excellent surface quality, facilitated by its good flowability during extrusion, which largely prevents friction, lines and sticking at the exit of the matrix.

The anodic layer is much thicker than the natural oxide layer, thereby ensuring permanent surface protection. This layer is characterized by its high resistance to corrosion and constitutes an excellent base for subsequent coloration due to its porosity.

Once the anodizing process has been carried out, it is necessary to carry out the sealing process so that the metal is perfectly protected against aggressive environments. Sealing is a process that reduces porosity and, therefore, its absorption capacity.

Alloy 6005 offers good corrosion resistance, even in harsh atmospheres. It is also not affected by stress corrosion cracking. This behavior means, in practical order, that structural or special protection is not necessary.

The anodizing process can be used to increase the protective effect that the surface has due to the transparent aluminum oxide. It is also used to give a decorative color.

At Extralum this process is based on the recommendations given by Qualanod, a member company of the European Association of Aluminum and Anodizing based in Zurich.

Among the advantages of anodizing are:

- Much more resistant (hard) than paint. Very good for high traffic areas where anodizing withstands physical and abrasive abuse
- Does not wear out. The layer is part of the metal or part
- Metallic color is deeper, not imitable with Paint

The following image shows the electrolysis process:

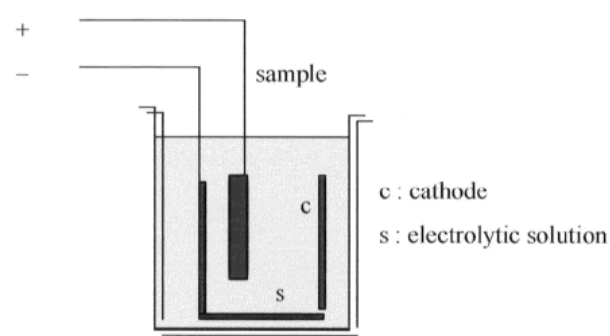


Imagen 1. Schematic representation of the electrolysis process

## Typical Cycle of the Anodizing Process

- Hook. It ensures adequate contact for the conduction of electricity.
- Degrease. It consists of applying chemical agents that remove oil, grease or other stains from the surface.

- Matting or Chemical Pickling. This process is carried out in a tank with caustic soda as a preparatory stage of the aluminum surface before anodizing.
- Anodized. Anodic oxidation electrolytic process. It is made with sulfuric acid by passing a direct electric current of about 1 to 2 amps per square decimeter. In the electrolytic cell, aluminum acts as an anode and current as a dissociation agent. The cathode is made of sheets of other material inside the cell (Image 2).
- Sealed. After anodizing, the anodic film is sealed in tanks with water and nickel salts at low temperatures. In this way, said film thus formed can have a thickness of 5 to 20 microns, depending on the use for which the material is required.

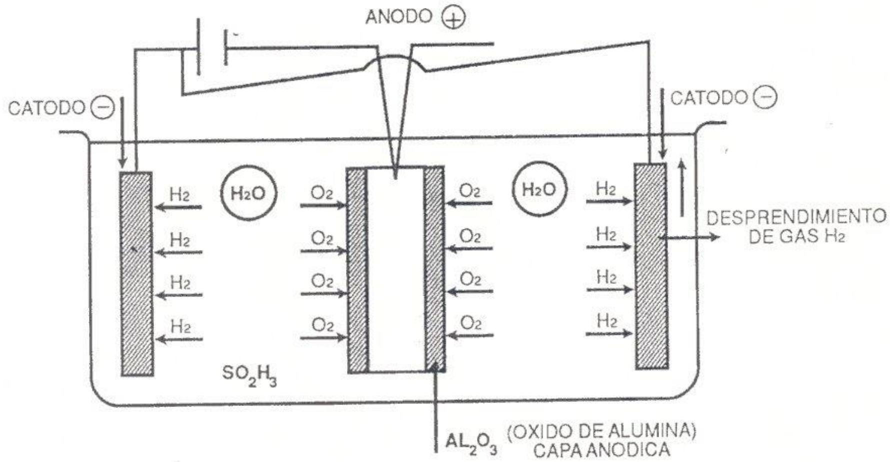


Imagen 2. Electrolytic anodizing cell

## Basic Types of Anodizing.

There are several types of anodizing processes. They differ mainly from the type of electrolytic solution used, the voltage and density applied, as well as the bath temperature. The anodic layers can vary significantly in thickness, hardness, porosity and protection value, depending on the process used and the treatment time.

- With sulfuric acid. It is the most used process
- With chromic acid. Mainly used in the aerospace industry
- With phosphoric acid
- With boric acid. Mainly used in specialized electrical applications
- With sulfuric acid for hard coating.

## Anodizing Considerations.

- Layer thickness
- Hardness of the layer
- Layer weight
- Effectiveness of sealing
- Corrosion resistance (salt chamber)
- Color uniformity
- Resistance to discoloration

## Recommendations.

- Regular cleaning with potable water is sufficient, other than hard or well water, applying a pressure jet to remove dirt residues. This is very useful, doing it regularly avoids the need to use subsequent chemicals (such as detergents).
- If dirt persists, use a neutral liquid detergent and scrub with a soft cloth. Then wash and perfectly remove the rest of the detergent.
- Never use abrasives, such as sponges or sandpaper, to avoid scratching the surface.
- Dry the metal after washing so that there are not many moisture residues that cause small stains.

## References and Bibliography


- "The Aluminum Extrusion Manual", Aluminum Association, First Edition, September 1987
- "News about Aluminum". Industrias Aragonesas del Aluminio, S.A. (INALSA), Zaragoza, Spain, Brochures No. 4, 5 and 6
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If you have any doubts, consult the Sales Department of Extralum, S.A.