Surface treatment

Anodizing, galvanizing, passivation, painting: Mifa offers customers all possible surface treatments. A good surface treatment can protect against corrosion, reduces wear or friction, can be electrically insulating or conductive, and in many cases makes the product visually more attractive. Mifa sees surface treatment as the finishing touch that not only increases durability but also adds extra functionality to the aluminium product.

The main surface treatments for aluminium that Mifa offers can be roughly divided into three categories:
- Conversion layers: aluminium passivation, anodizing, and plasma electrolytic oxidation
- Galvanic coatings: chemical nickel-plating, silver, gold, tin, hard chromium etc.
- Organic coatings, painting, paint primers, adhesive primers

CVD (Chemical Vapour Deposition), PVD (Physical Vapour Deposition), and synergistic coatings can also be applied on request.

CONVERSION LAYERS

Unlike many other coatings, a conversion layer uses part of the aluminium to form the layer. A simple way to do this is by applying chemicals that oxidize with the surface, converting the surface into a thin oxide skin. Examples include yellow chromate layers and passivation with phosphoric acid and/or metals.
A more complex surface conversion can be achieved by artificially oxidizing the surface through the use of electrical current and chemicals; this is called ‘anodizing’. In the anodizing process, thick oxide layers (5-100 μm) can be formed which greatly improve the abrasion resistance and corrosion protection of the surface.
Another process that, like anodizing, uses electricity and chemicals to form the surface is plasma electrolytic oxidation. What differentiates it from anodizing is that the process is arranged differently so that discharges occur, resulting in plasma that transforms the surface into a super-hard oxide.

ALUMINIUM PASSIVATION

Passivation is the simplest way to protect the surface from corrosion. The layer often contains active substances such as metals (chromium) which, similar to a zinc coating on steel, not only provide a thin, passive oxide skin but also additional corrosion protection. In the past, mainly white and yellow chromate layers were used for aluminium.
In recent years, however, reduction of the use of hexavalent chromium has led to the development of completely chromium-free versions and versions with trivalent chromium, such as Surtec 650, that are fully compliant with the RoHS guidelines. These passivation layers have properties that make them extremely suitable as a surface for paints or adhesives, corrosion protection, and the prevention of oxidation of electrical contacts.

ANODIZING

By far, the most commonly used surface treatment for aluminium is anodizing. Although we may not realize it, much of the aluminium we encounter in our daily lives is anodized (window frames, car parts etc.).
Like with passivation, anodizing uses part of the aluminium surface to form the layer, which is why it is referred to as a 'conversion layer'. Unlike passivation, this is done not only through exposure to chemicals but also through the use of electric current.
This is achieved by hanging the product on the anode during the process, and that is where the name 'anodizing' comes from. Under the influence of electrical current the surface converts to an oxide layer more rapidly and much thicker layers can be formed than for passivation layers.
Because the oxide layer is thicker and harder compared to a passivation layer the surface is better protected against corrosion, scratches, and wear. The anodized layer is also electrically insulating and offers the advantage of possessing a microporosity that can be used for impregnation with dye or lubricants. As such, anodizing not only adds functionality and protection to the aluminium product but also imparts a long-lasting, attractive finish to the product. This is in stark contrast to a non-anodized product, which generally becomes dirty and takes on a matt appearance as it ages.

PLASMA ELECTROLYTIC OXIDATION

Like anodizing, plasma electrolytic oxidation is a process in which a layer is formed through exposure to chemicals and electrical current. Due to the special chemicals/electrolyte and the high voltages that are applied, plasma discharges occur on the surface that melt the surface briefly and form a high hardness, tightly bound oxide layer. Examples of commercial processes based on this technique are Keronite and Keplacoat. The formed layer consists mainly of a porous outer layer and a less porous inner layer. Like an anodized layer, the porosity of this layer makes it suitable for dying or impregnation with lubricants. The hardness and abrasion resistance are usually higher than those achieved through anodizing.

GALVANIC COATINGS

When galvanizing aluminium a coating is precipitated on the product. Unlike conversion coatings, however, the aluminium product itself does not contribute to the formation of the coating.
The coating is precipitated onto the product under the influence of current or in certain cases without any current at all. During galvanizing the product is hung on the cathode, which causes the metal particles dissolved in the galvanizing bath to precipitate on the product.
Galvanic coatings therefore usually consist of a metal, possibly with small amounts of additives. Examples of metals that can be precipitated are gold, silver, tin, nickel, and chromium.
The effect of these coatings and their applications often differ from those of anodizing layers because the coating is much less affected by the aluminium alloy, which allows greater freedom of choice in the type of coating while also making it possible to coat high-alloyed aluminium alloys.

There are a few cases in which a metal layer can also be precipitated without current. A familiar example of this is chemical nickel-plating, which is precipitated onto a product without the use of electrical current.
Due to the large number of galvanic coatings and applications, it is beyond the scope of this article to discuss them all. Need advice? We are happy to help you choose the correct galvanic coating for your needs.

ORGANIC COATINGS

Organic coatings are coatings based on organic substances, usually called lacquer or paint. Besides a decorative and protective function, certain coatings also have specific properties. Some examples are non-wetting, low friction, self-lubricating, and corrosion protection. Substances that influence lubrication/friction or wetting are often fluoropolymer-based substances (e.g. Teflon) or ceramic lubricants that are added to an organic coating. In contrast to substances that prevent adhesion, adhesion improvers can also be added to coatings. This is often the case for adhesion primers that are used for purposes such as adhesive bonding. The special substances added to the primer, silanes for example, ensure strong, long-lasting adhesion to the aluminium surface and promote good wetting and adhesion of the applied adhesive.

THE ANODIZING PROCESS

The anodizing process has already been in use for many decades and has proven to be a cost-effective, versatile surface treatment for aluminium. The anodizing process offers a range of ways to vary the technical properties of the layer as well as its colour depending on the customer's wishes.
Because a small portion of the aluminium is consumed to form the coating during the anodizing process, the selected aluminium alloy has a direct effect on the properties of the layer.

Mifa understands this interaction between alloy composition and anodizing better than anyone and can therefore advise you concerning the choice of aluminium alloy to achieve optimum functionality of both the aluminium product and the anodized layer.

During the anodizing process the aluminium product is oxidized on the anode in a bath of sulphuric acid using electric current. The surface of the product is converted into extremely hard aluminium oxide.
The layer contains small pores that can be filled with dye to give the layer a decorative appearance. For optimum protection of the aluminium the pores in the layer are usually closed through a post-treatment, referred to as 'sealing'. This treatment can be performed in several ways: through impregnation, hot or cold sealing, or passivation with a corrosive agent.

ANODIZING PROCESSES

There are several processes for anodizing aluminium. The two most commonly used are normal and sulphuric acid anodizing.

Normal anodizing is the usual process, as the name implies, and produces a 10-25 µm thick anodized layer suitable for most applications where abrasion resistance, scratch resistance, corrosion protection and decorative characteristics are desired.
Hard anodizing is similar to normal anodizing. The difference is that the anodizing bath is highly cooled which makes it possible to produce harder and thicker layers. Hard anodizing is suitable for applications where thicker layers (20-100 µm) and/or higher wear resistance are needed.

The hardness and abrasion resistance of the layer varies depending on alloy, layer thickness, and post-treatment. Very thick anodized layers are softer on the outside and sometimes need to be ground to remove the soft top layer for optimum results. Therefore hard anodized layers do not necessarily provide a harder anodized layer than a normal anodized layer despite the name of the process. The effect of the alloy on the properties of the layer is greater than that of the layer thickness, so choosing the alloy, anodizing process, and any post-treatment is important to achieve an optimum combination of material and coating properties.

Both anodizing processes affect the dimensions of the product equally, but this ratio varies slightly by alloy and layer thickness.
Because the layer is formed from the aluminium, the layer can more or less be seen as 'growing' into the material. The consumed aluminium doubles in volume as it is converted to an anodized layer, which means that 10 µm aluminium is converted to an anodized layer approximately 20 µm thick.

Because the layer is formed from the aluminium and is not precipitated on the product as in the case of a galvanic coating, the dimensions change less: a 20 µm anodized layer grows on average around 10 µm into the material and expands in volume to approximately 10 µm beyond the original surface.

To avoid the effect on the dimensions the product can be pickled first to compensate for the volume growth; the final dimensions of the product are then unchanged.

COLOUR AND COLOURING

Because the anodized layer is formed from the aluminium alloy the product is made of, the alloy elements influence the colour of the layer. This effect becomes greater as the layer thickness increases. Hard anodized layers are therefore darker than normal anodized layers due to the greater layer thickness. If the layer thickness is less than 25 µm and not made from 2000 and 7000 alloys, the coating is almost completely colourless and ideally suited for colouration. Two techniques are used: absorption colouring and electrolytic colouring.

Absorption colouring is the most commonly used method and offers a wide range of colours, with the only exception being white. Organic dyes of the type used to colour clothing are used for this process, which explains why so many colours are possible. Absorption colouring is the least expensive colouring method, offers many colours to choose from, and is offered by most anodizing companies. The only drawback is that, as with clothing, the colours may be affected by UV light, so the colour may fade slightly over time.

Electrolytic colouring, like the name says, is a colouring method that involves the use of electrical current. Metals such as tin are deposited in the pores during colouring, resulting in colours ranging from gold to bronze and ultimately deep black. Other colours are also offered but are seldom seen on the market.
The advantage of absorption colouring is that the dye is insensitive to UV light and can withstand high temperatures. The disadvantage of this method is that the process is not widely available, is only suitable for normal anodizing, and only a limited number of colours are possible.

POST-TREATMENT OF ANODIZING LAYERS

For optimum protection of the aluminium the pores in the layer are usually closed through a post-treatment, referred to as 'sealing'. This treatment can be performed in several ways, such as through impregnation, hot or cold sealing, or passivation with a corrosive agent.

One of the most commonly used sealing methods is called 'water sealing'; in this process the aluminium oxide is converted into boehmite, which closes the pores.

This reduces the hardness and wear resistance of the layer slightly, but the corrosion protection improves dramatically. In general, anodizing layers are always sealed, but for applications where maximum abrasion resistance is desired (e.g. bearings) sealing is not performed, in order to maintain maximum wear resistance. The pores can also be impregnated with wet or dry lubricants such as Teflon or oils so that the layer is not only highly wear resistant but also has a very low coefficient of friction.
An example of a layer of this type that Mifa has offered for over 25 years is Tufram, which is an anodized layer that provides the unique combination of being very hard and having self-lubricating properties.

The pores in the layer can also be used for an entirely different purpose. Anodizing has been a standard in the world of adhesives for over 50 years and is still prescribed today for adhesive bonds that must withstand high loads.

CONCLUSION

After application of the anodized layer, any colouring or impregnation, and sealing, the layer can be processed further. Selective removal of the layer with a laser is also possible. This allows us to remove the anodized layer selectively, such as where electrical conductance is required, and of course we can even etch the product name, company name, or logo onto the product. Beautiful and durable!

Want to learn more?

Need advice? We are happy to help you choose the correct coating for your needs. Visit www.mifa.eu or contact us at sales@mifa.eu. If you'd like to contact us, call: +31(0)77 – 389 88 88

THE FACTS

SURFACE TREATMENT	MAX. LAYER THICKNESS	CORROSION PROTECTION	HARDNESS	WEAR RESISTANCE	GENERAL STANDARD
Anodizing	up to 20 µm	Max. 2000-hour salt spray test in accordance with DIN 50021 ESS	approx. 250 HV 0.025, depending on the alloy	Fair	MIL-8625 Type II
Hard anodizing	up to 100 µm, depending on the alloy	Max. 2000-hour salt spray test in accordance with DIN 50021 ESS	Up to approx. 500 HV 0.025, depending on the alloy	Good	MIL-8625 Type III
Glisscoat	up to 20 µm	in accordance with DIN 50021 ESS	Up to approx. 500 HV 0.025, depending on the alloy	Good	MIL-8625F Type III
Tufram	25-50 µm	> 1000 uur	360 +/- 20HV	Good	MIL-8625 Type III
Chemical nickel plating	up to 80 µm	>200 hours, in accordance with DIN 50021 ESS	Up to approx. 950 HV, depending on process	Good	MIL-C-26074
Surtec 650	<1 µm, without affecting the dimensions	max. 336-hour salt spray test in conformance with DIN EN ISO 9227 ASMT B-117	n/a	n/a	MIL-DTL-81706-B and MIL-DTL-5541-F

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