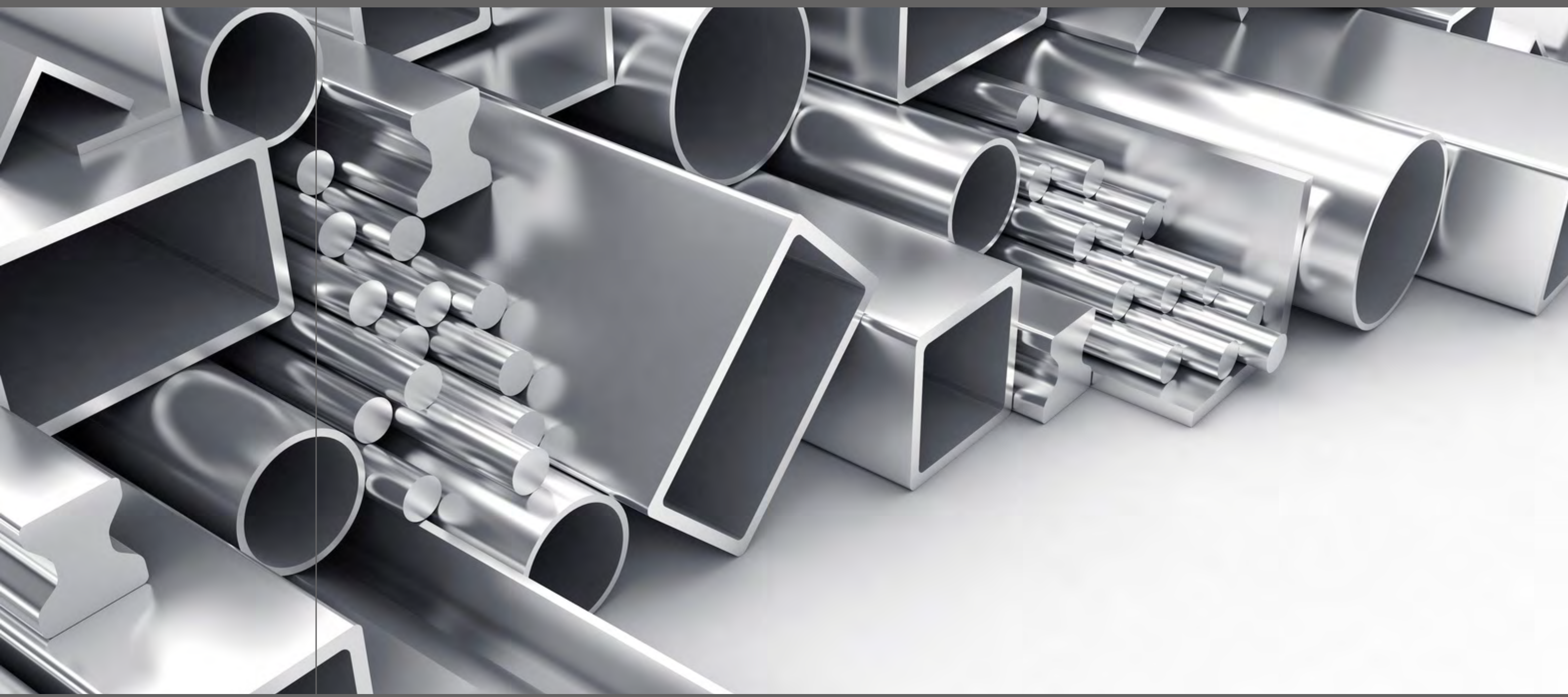
THE DRIVE OFF ROAD

NEWSLETTER



TOPIC

ALUMINUM SURFACE TREATMENT – AST

COVENTYA

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1 ALUMINUM BACKGROUND INFORMATION

Aluminum, mainly due to its light weight, functionality and availability, is one of the key engineering materials of our time. We find aluminum everywhere in our daily lives. The homes we live in, the automobiles we drive, the trains and airplanes for long distance travel and electronic devices like cell phones and computers.

Aluminum, a silvery-white metal, is the 13th element in the periodic table. It is the most widespread metal on Earth, making up more than 8% of the Earth's core mass. It's also the third most common chemical element on our planet after oxygen and silicon.

Fig. 1: Chemical element Aluminium with symbol Al and atomic number 13

Due to its tendency to react easily with other elements, especially oxygen, pure aluminum does not occur in nature. Aluminum was produced for the first time in 1824 and it took another fifty years to learn to produce it on an industrial scale.

2 PROPERTIES OF ALUMINUM

Aluminum offers a wide array of properties. It is one of the lightest metals in the world; almost three times lighter than iron but don't call it a lightweight. It's weight to strength ratio and flexibility make it a go to material for some of the most challenging applications in the world. It also offers high corrosion resistance, a result of its ever present thin layer of oxide. It is completely non-magnetic but provides very good electrical conductivity. Furthermore it forms alloys with almost all other metals.

In the industry, aluminum is typically used in form of panel sheets, profiles or cast material.

Name:	Aluminum
Symbol:	Al
Appearance:	Silvery gray metallic
Atomic number:	13
Atomic weight:	26,9815386
Phase:	Solid
Melting point:	933,47 K (660,32 °C, 1220,58 °F)
Density at r.t.:	2,70 g/cm3

3 USE OF ALUMINUM

Its light weight and excellent workability makes aluminum the most widely used non-ferrous metal. In the transportation industry it is used as sheet, tube and castings. Many car body parts are made of aluminum in modern cars. In the building industry, aluminum can be found in windows, doors, building wires, roofing, etc.

Due to its good resistance to corrosion, aluminum is often used in packaging, i.e. for food and beverage cans and containers.

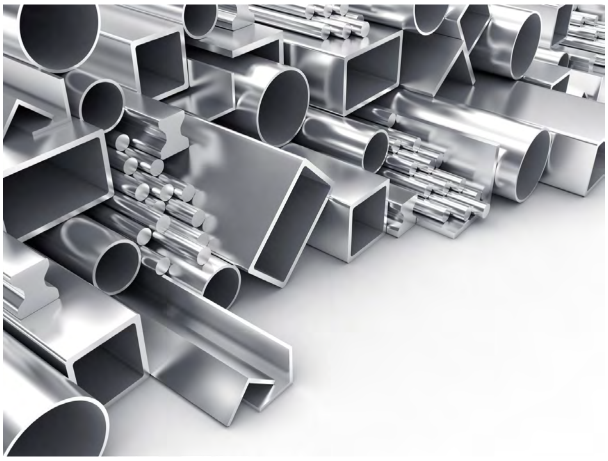

Fig. 2: Aluminum

4 WHY ALUMINUM SURFACES ARE TREATED

When exposed to air, Aluminum immediately forms a natural oxide film which provides the corrosion resistance. The thickness of that layer is approx. 50 nm (0,05 µm) and therefore provides only a limited corrosion resistance with less than desirable aesthetics. Thus, a surface treatment is required to achieve:

- Decorative appearance
- Highest corrosion resistance
- Wear resistance
- Combination

Fig. 3: Aluminum facade

5 DIFFERENT WAYS TO TREAT ALUMINUM SURFACES

Preparation – cleaning and etching

Aluminum has a standard electrode potential of -1,676 V and is therefore a very non noble material. Before any other surface treatment can be done, the ever present oxide layer must be removed as well as any potential oil or grease from earlier mechanical process steps.

Aluminum is amphoteric and will therefore be attacked in both acidic and alkaline media. Therefore the most efficient cleaning process with least substrate attack should be chosen. There are neutral, mild alkaline, alkaline and acid cleaners available. Neutral cleaners typically remove small amounts of oil and slight contamination. Mild alkaline cleaners remove stronger soils and slight oxide films but can cause slight substrate attack. Alkaline cleaners are used in case of very strong oils and/or soils, i.e. grease and polishes but will lead to aggressive substrate attack and must be used carefully. Acidic cleaners are usually much more mild and are only effective in removing very modest soils however they are effective in removing alloying constituents that can impair subsequent finishing operations.

Etching is mainly done in a high alkaline caustic solution which are able to remove very thick oxide layers, for example, anodizing films. When used with right additives, it also can provide the surface with a uniform matte appearance. This is called “E6” etching in the anodizing world. Die marks – as from the aluminum tube and profile production – will almost be completely removed, delivering a more uniform decorative appearance.

Another specific preparation step is the zincate. It acts by simultaneously removing the tenacious oxide film from aluminum substrate and immediately forming, in-situ, a thin layer of immersion zinc. This thin layer of zinc eliminates formation of the oxide in subsequent rinses and allows direct electroplating with other metals.

PEO – plasma electrolytic oxidation

Plasma electrolytic oxidation (PEO), also known as micro arc oxidation (MAO), is an electrochemical surface treatment process for generating oxide coatings. It is similar to anodizing, but it employs higher potential, so that discharges occur and the resulting plasma modifies the structure of the oxide layer. This process can be used to grow thick (tens or hundreds of micrometers), largely crystalline, oxide coatings on metals such as aluminum. These layers show a high hardness and a continuous barrier. Thus such layers are mainly used as wear resistance and electrical insulation.

Anodizing

There are different types of electrolytes known to anodize aluminum: sulfuric acid anodizing, chromic acid anodizing, phosphoric acid anodizing, boric and tartrate anodizing baths. The most common is the sulfuric acid process, used mainly in the construction and building industry.

During the anodizing process, the substrate is converted into aluminum oxide.

$$4\,Al + 3\,O_2 \rightarrow 2\,Al_2O_3$$

Fig. 4: Car with anodised components

The conventional anodizing process is mainly dedicated to corrosion protection and decorative surfaces. Two thirds (⅔) of the oxide layer grows into the substrate and just one third (⅓) builds up additional thickness. That means an 18 µm thick anodizing layer just creates 6 µm of dimension growth. The layer consists of a very thin barrier layer, followed by a honeycomb structure full of pores. The layer growth is vertical to the substrate surface. When the Vickers hardness is measured, the Vickers diamond pyramid compresses the honeycomb structure by squeezing the oxide layer into the pores. Thus, the real hardness is not detected but rather, the so called "apparent hardness".
A conventional anodizing layer achieves an apparent hardness of 180 – 300 HV.

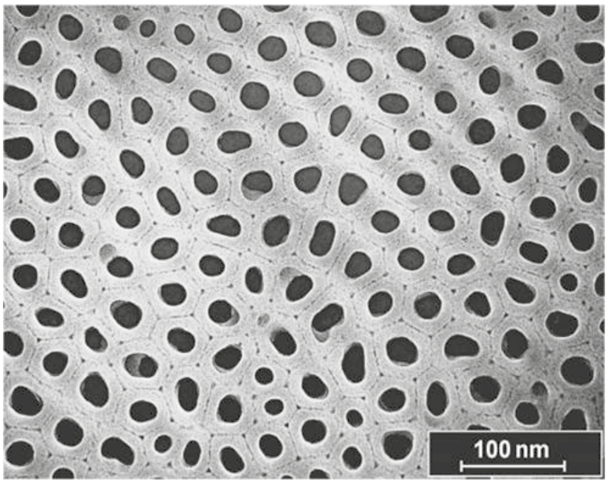

Fig. 5: Source: TU Chemnitz, Institute for material science and materials engineering

Hard anodizing processes are typically carried out to create wear resistant layers. The main difference from conventional anodizing process is that the system is chilled down, i.e. to – 4 °C (24,8 °F). This increases the conductivity resulting in smaller pore size. Apparent hardness values of up to 500 HV can be achieved. Hard anodized oxide layers grow 50% into the substrate and build up another 50% of additional thickness.

Hard anodized materials will exhibit self-coloration, due to dispersion of alloy metals that cannot be anodized, i.e. Silicon. Such self-coloration cannot be modified and mainly show irregular shades of gray. Conventional anodized aluminum surfaces can be purposely colored, therefore the aluminum alloy must have a certain purity, better known as anodizing quality. These types of aluminum typically contain less than 3% alloyed elements. The colorization is done by incorporation of colorants into the pores. There are mainly two different technologies available. One is to immerse the anodized workpiece into a solution of specific nano-sized pigments which are adsorbed into the pores. The longer the immersion time, the more pigments are incorporated and therefore the more intense the coloration is. The second way is an electrolytic process, where by the use of alternating current (AC), Tin(II)Sulfate is incorporated into the pores. This process creates bronze coloration from light bronze (C-31) to black (C-35).

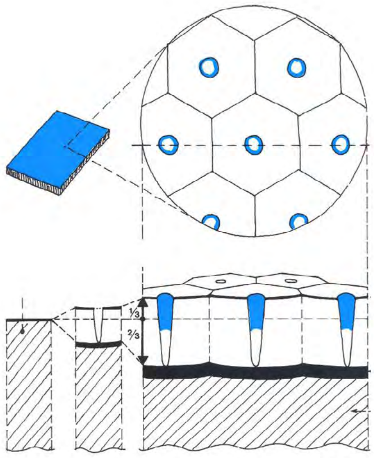

Fig. 6: Adsorptive coloration of anodizing layers

Fig. 7: EURAS color standard C0 – C35

As a final process step, the pores of colored anodizing layers as well as non-colorized, need to be sealed. The classical method involves immersing the parts into hot water 98 °C (208 °F) that contains metal salts or other additives to increase the corrosion resistance. . This is known as a sealing process. During this treatment, aluminum hydroxide is created in the pores, and therefore closes them. This treatment has no influence on the appearance of the colored surfaces. Today, there is an alternative process called cold-sealing and COVENTYA's trivalent Chrome based LANTHANE 613.3 has quickly gained market attention. During the cold-sealing process, Chromium and Zirconium are incorporated into the layer. The distribution of these elements is uniform and they are located in the top of the layer. The concentration (layer weight) of Zirconium is 1.150 – 1.700 mg/m2, five times higher than the concentration of Chromium.

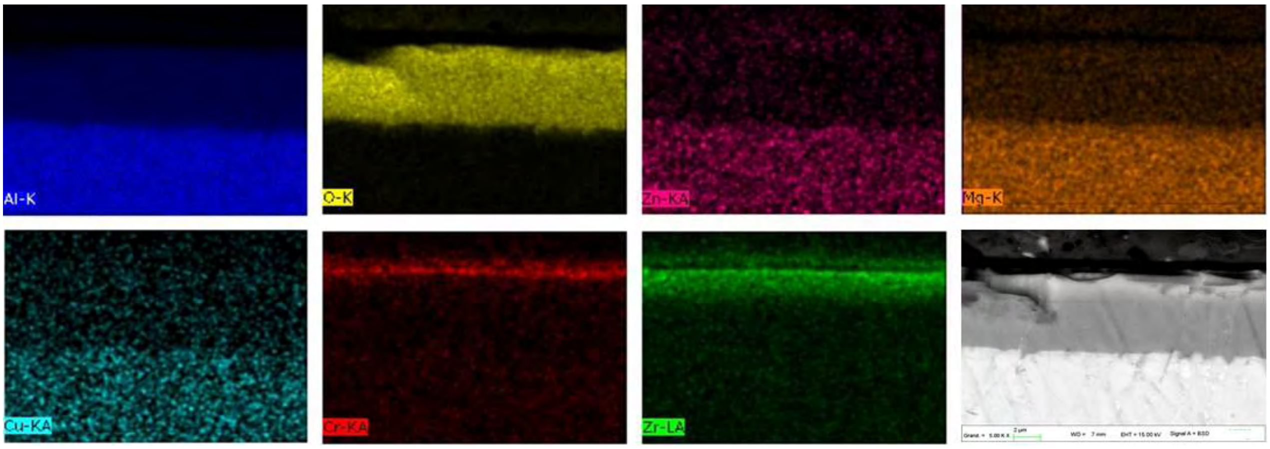

Fig. 8: SEM examination (back scattered electrons) of anodized 7175 T351 sealed with LANTHANE 613.3

LANTHANE 613.3 cold sealed anodizing layerscan achieve very high corrosion resistance.

Passivation

Aluminum substrates can be passivated, either to improve corrosion protection or as preparation before painting or powder coating. LANTHANE 613.3 is an excellent passivate for many different aluminum types and aluminum alloys. It builds a conversion layer for high corrosion protection or as an excellent primer for paints and powder coats.

A uniform and rough layer is formed with a low density of micro cracks. Typical thickness is between 50 and 200 nm.

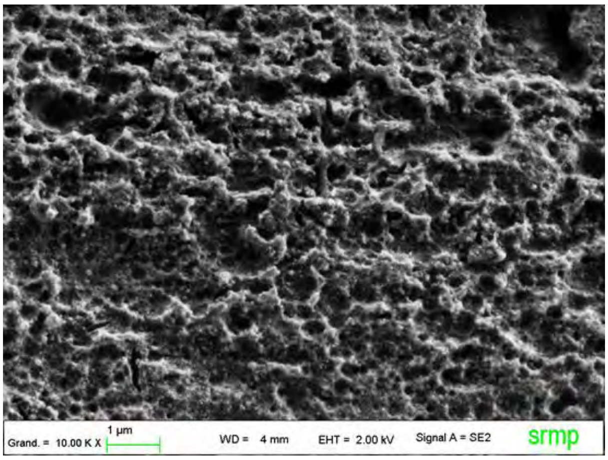

Fig. 9: SEM examination: surface (2024T3)

Fig. 10: SEM examination: fracture (7075)

The corrosion resistance in the salt spray test according to ISO 9227 is very high, also for critical such as copper containing alloys. In general, the resistance is very much dependent on the aluminum alloy and substrate composition. The preparation before passivating is a critical process step and will also influence the corrosion resistance after passivating. The corrosion protection of different aluminum alloys, passivated with LANTHANE 613.3 can be seen in the table below:

ALLOY	COMPOSITION	NSST (ISO 9227)
1050	Al	> 500 h
2024	Al-Cu	> 96 h
5005, 5754	Al-Mg	> 500 h
6060, 6061	Al-Mg-Si	> 500 h
7020	Al-Zn	> 300 h
7075	Al-Zn-Cu	> 168 h
42100 42200	AlSi7G0,3 AlSi7G0,6	> 336 h
44100	AlSi12	> 336 h
46000	AlSi9Cu3	> 168 h

Table 1: Corrosion resistance according ISO 9227 of LANTHANE 613.3 passivates aluminium substrates

Metallization

When aluminum is prepared in a zincate solution, as described in the “preparation” paragraph, it can be electroplated in principle as any other metal as well. The layering sequence for a chrome plated wheel after zincate solution for example is:

- Matte nickel/Alkaline copper
- Bright acid copper
- Semi bright nickel
- Bright Nickel
- Chrome

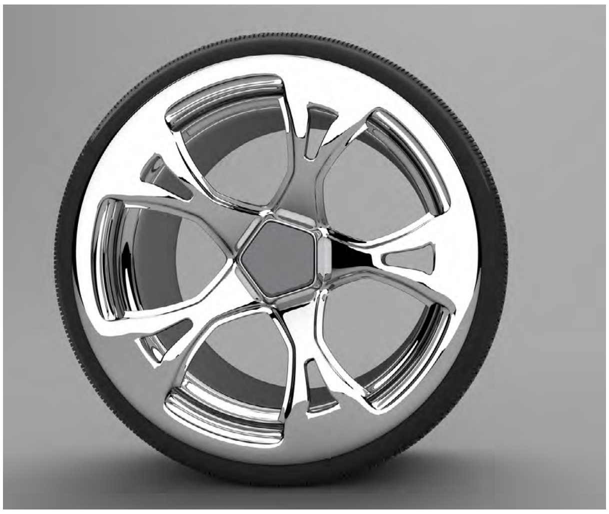

Fig. 11: Decorative chrome plated aluminium wheel

6 COVENTYA – EXPERTISE IN ALUMINUM SURFACE TREATMENT (AST)

COVENTYA has had a comprehensive product line for aluminum surface treatment (AST) for many years. As of today, COVENTYA has
14 product approvals for AST from major OEM’s in a variety of industries that include aerospace, automotive and the construction/building industry.
COVENTYA has recently acquired a significant interest in Borsa Istanbul-listed Politeknik Metal SanayiveTicaret A.Ş. (“Politeknik”), a leading manufacturer of aluminum surface treatment (“AST”) chemicals and the corresponding application equipment. Politeknik, which has a world class manufacturing facility in Tuzla, Istanbul, also has an affiliated company in the USA, based in Atlanta. COVENTYA expects to utilize its worldwide distribution network and further penetrate the AST chemicals market in the USA and Europe.

The lightweight properties of aluminum are driving growth in the automotive, construction and several other critical industrial sectors. Further to its own product range, mainly established in the aerospace sector, COVENTYA sees the addition of the rich Politeknik portfolio as a perfect addition, including its vast number of processes with QUALICOAT or QUALANOD approvals.

7 CONCLUSION

Aluminum is an important construction material for many industries. There are many different ways to treat aluminum, depending on the aluminum alloy and the intended use of the finished product.
COVENTYA has a full product line for aluminum surface treatment solutions and has proven to be a competent partner in many industries via our worldwide AST experts. Aluminum is a metal with a very bright future and COVENTYA is poised to support our partners in making sure that what they start is finished properly.

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