QUALITY ASPECTS OF PRE-ANODISED ALUMINIUM

Overview of norms and standards

The EN 12373 series of standards are being replaced by the ISO standards, each of which is being modified based on its equivalent EN 12373 part or parts. The table below includes both the EN 12373 part and its EN ISO equivalent.

Standard reference	Subject
EN12373-1:2001 ISO7599:2010	Anodising of aluminium and its alloys – General specifications for anodic oxidation coatings on aluminium
EN12373-2:1998 ISO2106	Anodising of aluminium and its alloys – Determination of mass per unit area (surface density) of anodic oxidation coatings. Gravimetric method.
EN12373-3:1998 ISO2128:2010	Anodising of aluminium and its alloys – Determination of thickness of anodic oxidation coatings. Non-destructive measurement by split-beam microscope.
EN12373-4:1998 ISO2143:2010	Anodising of aluminium and its alloys – Estimation of loss of absorptive power of anodic oxidation coatings after sealing – Dye spot test with prior acid treatment.
EN12373-5:1998 ISO2931:2010	Anodising of aluminium and its alloys – Assessment of quality of sealed anodic oxidation coatings by measurement of admittance.
EN12373-6:1998 ISO3210:2010	Anodising of aluminium and its alloys – Assessment of quality of sealed anodic oxidation coatings by measurements of the loss of mass after immersion in phosphoric acid/chromic acid solution.
EN12373-7:2002 ISO3210:2010	Anodising of aluminium and its alloys – Assessment of quality of sealed anodic oxidation coatings by measurement of the loss of mass after immersion in phosphoric acid/chromic acid solution.
EN12373-8:1998 ISO6581:2010	Anodising of aluminium and its alloys – Determination of the comparative fastness to ultra-violet light and heat of coloured anodic oxidation coatings
EN12373-9:1998 ISO8251	Anodising of aluminium and its alloys – Measurement of abrasion resistance of anodic oxidation coatings.
EN12373-11:2000 ISO7688:2010	Anodising of aluminium and its alloys – Measurement of specular reflectance and specular gloss of anodic oxidation coatings at angles of 20°, 45°, 60° or 85°.
EN12373-12:2000 ISO6719:2010	Anodising of aluminium and its alloys – Measurement of reflectance characteristics of aluminium surfaces using integrating-sphere instruments.
EN12373-13:2000 ISO7759:2010	Anodising of aluminium and its alloys – Measurement of reflectivity characteristics of aluminium surfaces using a goniophotometer or an abridged goniophotometer.
EN12373-14:2000	Anodising of aluminium and its alloys – Visual determination of image clarity of anodic oxidation coatings – Chart scale method.

ISO10215:2010	
EN12373-15:2000 ISO3211:2010	Anodising of aluminium and its alloys – Assessment of resistance of anodic oxidation coatings to cracking by deformation.
EN12373-16:2001 ISO2085:2010	Anodising of aluminium and its alloys – Check for continuity of thin anodic oxidation coating – Copper sulphate test.
EN12373-17:2001 ISO2376:2010	Anodising of aluminium and its alloys – Determination of electric breakdown potential.
EN12373-18:2001 ISO8993:2010	Anodising of aluminium and its alloys – Rating system for the evaluation of pitting corrosion – Chart Method.
ISO12373-19:2001 ISO8994	Anodising of aluminium and its alloys – Rating system for the evaluation of pitting corrosion – Grid method.
ISO2360:2003	Non-conductive coatings on non-magnetic electrically conductive basis metals. Measurement of coating thickness. Amplitude-sensitive eddy current method.
ISO2135:2010	Anodising of aluminium and its alloys – accelerated test of light fastness of colored anodic oxide coatings using artificial light.
ISO7583:1986	Anodising of aluminium and its alloys – Vocabulary
ISO9227:2006	Corrosion tests in artificial atmospheres – Salts spray tests.

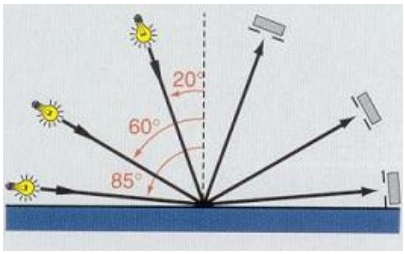
Gloss measurement

The measurement of gloss is important in projects where a lot of anodised sheets are mounted together (e.g. Facades).

The gloss value is mainly determined by the substrate, and our process can adjust this value only within a certain range and with approved substrates.

Measurement principle:

- The measurement is done by the reflection of light. Light will fall on the metal under a certain angle (20°, 60° or 85° parallel with the rolling direction) and the reflected light will be measured. The gloss is expressed in gloss units.
- With Coil's continuous anodising process, measurement angles of 60° or 85° are used.



Anodic layer thickness

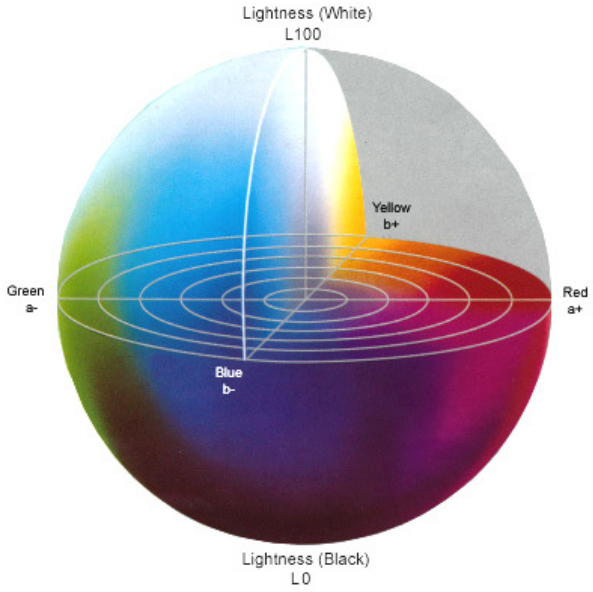
The anodic layer thickness is measured with an isoscope, based on the principle of Eddy Currents. These currents are created through electromagnetic induction. When an alternating current (AC) is applied to a conductor, a magnetic field is developed in and around this conductor.

- When another conductor is brought into the proximity of this magnetic field, a current will be induced in this conductor.
- To measure the anodic layer thickness (which is non-conductive) a conductor is used to setup an alternating magnetic field at the surface of the instrument's probe.
- If the probe is brought near a conductive surface (the aluminium substrate), the alternating magnetic field will setup eddy currents on it. The distance of the probe from the substrate affects the magnitude of the Eddy Currents. This distance is the thickness of the non-conductive anodic layer thickness.

The nominal anodic layer thickness will be the minimum anodic layer thickness.

Color measurement

- A color can be expressed in a 3-dimensional system, based on 3 axes :
  - L*-axis : black – white
  - a*-axis : green – red
  - b*-axis : blue – yellow
- The color measurement point will be expressed by a combination of L*, a* and b*.
- A color difference between 2 measurements can be expressed as a delta E value in accordance with the formula : delta E^2 = delta L^2 + delta a^2 + delta b^2



Sealing

The sealing quality is very important as a good sealing will determine various characteristics of the anodic layer such as:

- abrasion resistance
- anti-fingerprint behavior
- hardness
- corrosion resistance
- non-fading of the color
- light stability

Mass loss test

The sealing quality will be expressed by a mass loss test in accordance with the standard ISO3210.

- With this test, a test piece of 1 dm2 will be immersed in an aqueous phosphoric acid / chromic acid solution for 15 minutes.
- This solution will dissolve any unsealed anodic layer. This will result in a loss of weight and the well-sealed anodic layer will be left.
- The bare aluminium will not be attacked as the Cr6+ will passivate the aluminium.
- The test piece will be weight before and after the immersion. The loss of mass is calculated and will be expressed in mg/dm2.

Guarantee for General purpose and architectural applications

Standard (Coil)	Architectural and designer (Coil)	Qualanod
25 mg/dm2	20 mg/dm2	30 mg/dm2

Dye spot test

The sealing quality can also be expressed by the dye spot test, in accordance with standard ISO2143.

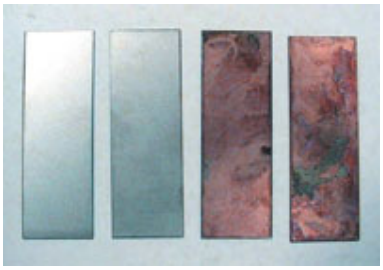
- Information on the sealing quality will be given by testing the resistance of the anodic layer to the absorption of dyes.
- A drop of a specified acid solution will attack the test surface. After that the test surface will be washed and dried.
- Consecutively, a drop of a specified dye is allowed on the same spot. After washing and slightly whiting the surface with a light abrasive, the test area is examined to assess the intensity of the stain.
- The intensity will be compared with a standard, and the loss of absorptive power is expressed as a numerical value : an excellent sealing quality will result into a loss of absorptive power whilst a poor sealing quality will not have a loss in absorptive power.

Continuity of the anodic layer

The continuity of the anodic layer is evaluated with a Copper Sulfate Test in accordance with Standard ISO2085.

Measurement principle:

- Drops of copper sulfate reagent are put on surface areas of about 100 mm².
- If the area includes points where the metal is bare or poorly covered by an anodic layer, a chemical deposition of copper takes place on the aluminium, accompanied by a release of gas (H2).
- After the test, black and / or dark reddish spots can be seen where the coating is not continuous.



Corrosion resistance of continuously anodised aluminium

Bare aluminium will spontaneously react with water or moist air and the result will be an aluminium oxide layer. This oxide layer acts as a protective barrier.

This natural oxide may quickly deteriorate and different forms of corrosion attacks will be possible.

Anodising will replace the thin natural oxide layer by a structured, highly resistant layer.

Accelerated corrosion tests have been executed to assess the performance of pre-anodised aluminium. Since these have been done in the lab as a simulation of different environments, experience out of daily life and use has been gathered in our building inspection report.

Detailed reports regarding the accelerated corrosion tests or on the building inspection report can be obtained upon request.

Neutral salt spray test

- According to standard ISO9227.
- The corrosion resistance will be evaluated in a NaCl environment, which simulates marine environments.
- Samples with anodic layers of 10 and 15 microns have been exposed to this environment during 1000 hours. Afterwards pitting corrosion, as a result of the attack, is made visible and an assesment is made which can be done on 2 ways :

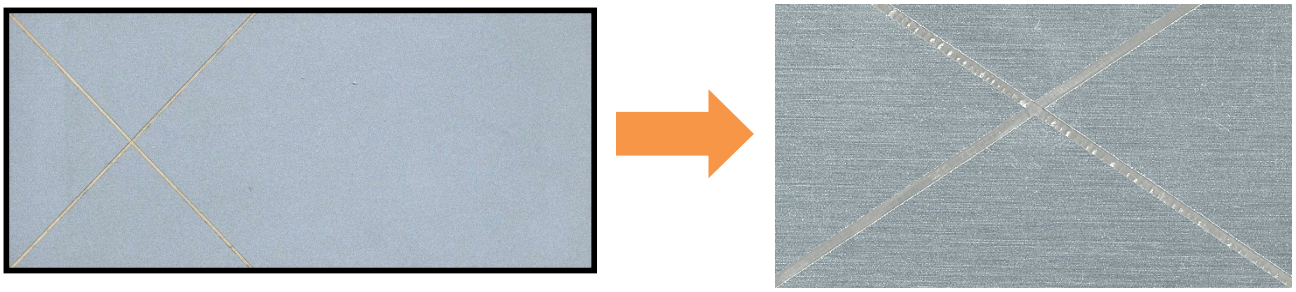
- The pitting density and sizes are compared with figures, the so called Chart Method in accordance with standard ISO8993.
- Grids of 5 mm squares have been made and the number of squares with at least 1 pit is counted, the so called Grid Method in accordance with standard ISO8994.
- Conclusion of the test :
    - No pitting corrosion attack
    - No preferential corrosion on bent, deformed or machined parts of the samples
    - No filiform corrosion

Kesternich test

- According to standard ISO6988.
- The corrosion resistance will be evaluated in a sulphur dioxide environment which is representative for an industrial environment.
- The test consists out of a cyclic wetting and drying whereas 1 cycle consists out of :
    - 8 hours exposure to a SO2 atmosphere (100% RH at 40°C)
    - 16 hours exposure to an ambient atmosphere (70% RH at 23°C)
- Testing during 42 cycles
- Evaluation in accordance with standard ISO10289 :
    - Evaluation of the ability to protect the substrate from corrosion
    - Evaluation of the ability to retain the integrity
- Conclusion of the test :
    - Good corrosion protection with anodic layers of 15 µm and more.

Weather resistance

- Evaluation of the resistance of anodised aluminium against exposure to humid atmospheric conditions at elevated temperatures.
- Tropical test in accordance with DIN50017 :
    - Samples in a climatic chamber (100%RH and 40°C)
    - Evaluation for traces of corrosion and changes in appearance after 200h, 450h, 650h and 1000h.
- Conclusion of the test :
    - Excellent protection
    - Corrosion is initiated in the carved cross, but does not propagate outside these carvings.



Building inspection report

A study has been executed on different buildings, with service lives even more than 30 years, by an independent engineering group.

Summary of the study :

- Not any trace of erosion of the anodic layer.
- The anodic layer thickness remained unchanged to their initial thickness.
- No deterioration due to adhesion, failures, blooming, peeling, blistering, cracking, …
- None of the clear or bronze anodised surfaces has been subject to color fading, color shifting or yellowing.

Quality Standard Continuous Anodising (QSCA)

Since 1972, Coil has been the undisputed leader in continuously anodised aluminium. It has achieved and maintained this leading position thanks to quality and its own Quality Standard for Continuous Anodising (QSCA).

The relevant product quality requirements for anodising following the QSCA are stricter than those in the International Standard ISO7599:2010 and the German Standard DIN17611:2007-11.

Product property	**QSCA**	**ISO7599:2010**	**DIN17611:2007-11**
Anodic layer thickness	Anodic layer thickness measured **at any point** on the anodised surface **>= 100% of specified layer thickness**	Anodic layer thickness measured **at any point** on the anodised surface **>= 80% of specified layer thickness** and average of 5 measurements of the surface measured >= specified layer thickness	Anodic layer thickness measured **at any point** on the anodised surface **>= 80% of specified layer thickness** and average of 5 measurements of the surface measured >= specified layer thickness
Sealing of the anodic layer	Weight loss test results following ISO3210 **lower than 20 mg/dm²**	Weight loss test results following ISO3210 **lower than 30 mg/dm²**	Weight loss test results following ISO3210 **lower than 30 mg/dm²**
Visual inspection of the surface during anodising	Surface inspected from a distance of maximum **1 m**	To be agreed between customer and anodiser	Surface inspected from a distance of **2 m** for interior applications and **3 m** (ground floor) or **5 m** (upper floors) for exterior applications

Backside quality	• Smooth, without any roughness • Free of rainbow • Minimum anodic layer thickness >= ¼ of the top side	No requirements specified.	No requirements specified.
Continuity of the anodic layer	Copper sulphate Test following ISO 2085 : no points per cm^2 allowed	To be agreed between customer and anodizer	No requirements specified
Gloss	Maximum gloss difference 10 gloss units inside a coil and 15 units inside an order (over several coils)	To be agreed between customer and anodizer	To be agreed between customer and anodizer
Aluminium substrate	Substrate in **Anodising Quality** required **and** substrate must have been **homologated by Coil**.	No explicit recommendations or obligations. Just some guidelines.	Substrate in **Anodising Quality** required.

Certifications

Coil is certified ISO 9001:2008.

Certificate of Compliance

For Architectural Applications, a Certificate of Compliance may be requested. This Certificate provides you with supplementary measurements, documented and certified.