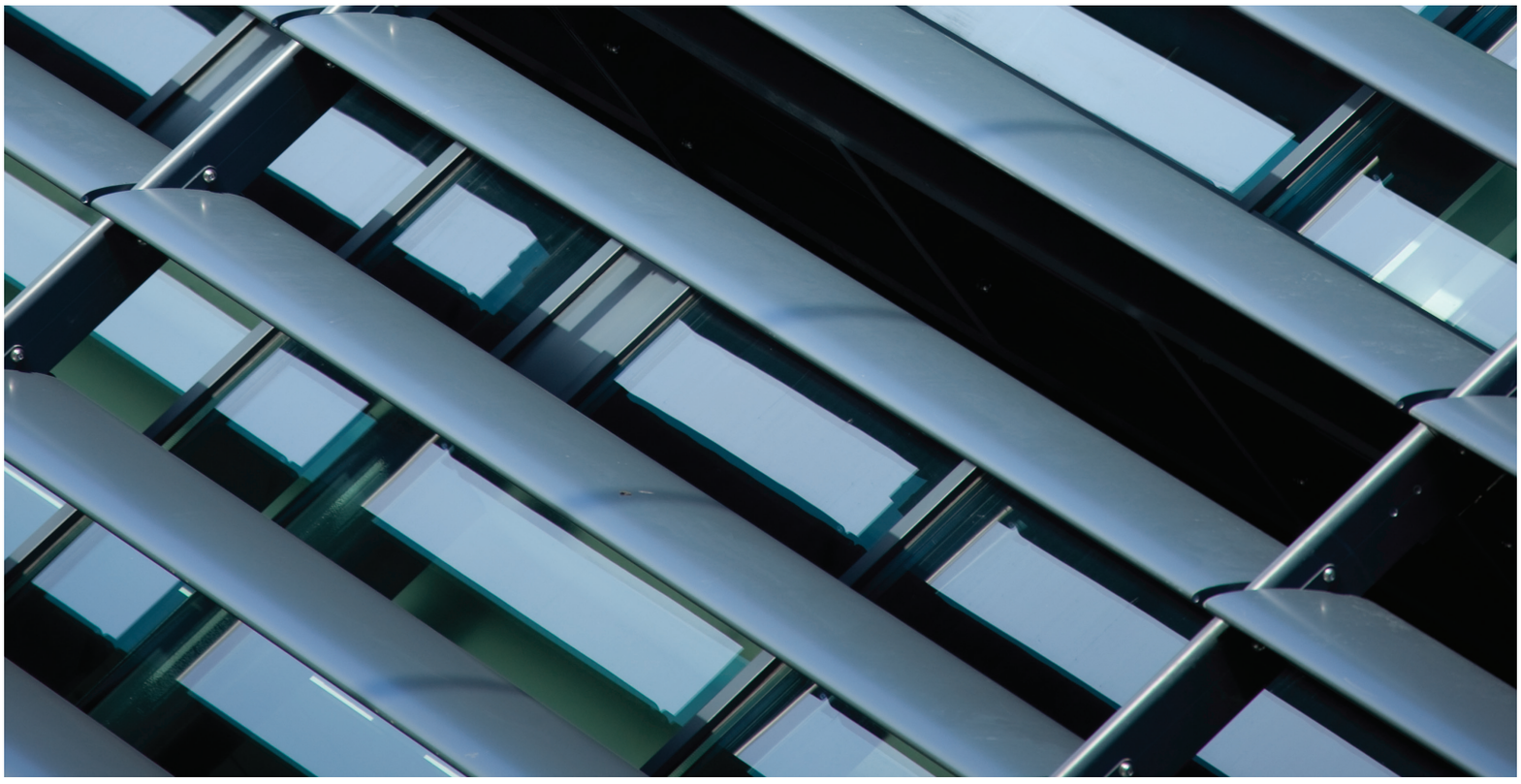
coating aluminium castings



a technical research paper

technical information

the

global

standard

for

architectural

aluminium

finishing

powder coating of aluminium castings

Powder coating of aluminium castings can be a challenge, particularly if there are contaminants present within the casting during the pretreatment and coating of the cast parts.

This document provides some in-depth research undertaken by Qualicoat and contains important data for use between the casting provider and powder coat processor to ensure good life expectancy of powder coated hardware for the fenestration industry.

technical information

Technical Information Sheet 2

April 2015 Edition

1. Introduction

Corrosion tests are among the most important tests to predict the behaviour of an organic coated surface. Each test for accelerated corrosion, however, provides an indication relating to a specific environmental characteristic, for example the SO_2 (sulphur dioxide) corrosion test simulates industrial environments, while the salt spray tests simulates the marine environment. In the case of coated aluminium, it is the Acetic Salt Spray test that is used, this is more onerous than the previous neutral salt spray test with a pH close to neutral.

QUALICOAT has extensive experience in undertaking research based on the Acetic Salt Spray test (AASS) following ISO 9227. The QUALICOAT specification requires that corrosion checks tests performance on 3 samples taken during the first yearly routine visit; the results of these tests are monitored yearly and results discussed within the QUALICOAT Committees.

In this technical information sheet we report the results of a testing program that has checked the influence of the chemical composition aluminium products produced by the casting process. The main scope of the testing is to give more technical information in reference to Appendix A5 in the QUALICOAT Specification.

With the alloys used in the casting process (EN 1706) the composition is influenced by the concentration of Silicone (Si), which can be up to 15% by mass. Without any special pretreatment it becomes very hard to pass the 1,000 hours in the Acetic Acid Salt Spray (AASS) test. We must also consider that in coating cast alloy the influence of Copper (Cu) is also of great concern on the life expectancy of the finish.

As the worlds leading architectural finishing association, QUALICOAT decided to investigate the influence of Cu on corrosion resistance. The testing program was developed by the French association (ADAL) in collaboration with the Italian Association (QUALITAL). In this technical information sheet we discuss the test program and the results.

2. Testing Programme

2.1 Surface preparation of the samples

The samples were treated in a powder coating plant to the following steps:

No.	Function
1	Degreasing
2	Rinsing
3	Alkaline Etching
2	Rinsing
5	Rinsing
6	Acid Desmutting
5	Rinsing
8	Rinsing
7	Conversion Coating
8	Rinsing
9	Rinsing
10	Drying Oven

2.2 Coating Material

In order to ensure consistent results, both the RAL colour and the supplier have been determined. QUALICOAT has decided to use only one colour, RAL 9010, for TGIC free powder coating of categories 3. and QUALICOAT approval.

2.3 Sample Codifications

The codification of the samples used in the corrosion tests were:

Type of Alloy	Type of process and description			
	Traditional pretreatment Chromium ISO 10546		Alternative pretreatment Chromium free	
	Standard Pretreatment Acid Etching	SEASIDE Pretreatment Type AA	Standard Pretreatment Acid Etching	SEASIDE Pretreatment Type AA
EN_AC_42200 AlSi7Mg0,6	A-A-1	A-D-1	A-C-1	A-B-1
	A-A-2	A-D-2	A-C-2	A-B-2
	A-A-3	A-D-3	A-C-3	A-B-3
EN_AC_44200 AlSi12Cu	B-A-1	B-D-1	B-C-1	B-B-1
	B-A-2	B-D-2	B-C-2	B-B-2
	B-A-3	B-D-3	B-C-3	B-B-3
EN_AC_46200 AlSi9Cu3	E-A-1	E-D-1	E-C-1	E-B-1
	E-A-2	E-D-2	E-C-2	E-B-2
	E-A-3	E-D-3	E-C-3	E-B-3

Results

Corrosion tests were carried out on one coated sample only, the results of which follow in the table.

A - Thickness

Sample	Measurement (µm) 1	2	3	4	5	Mean Value (µm)	Standard Deviation (µm)	Coefficient of Variation %
EN AC 42200 AA3	109	102	121	124	103	112	10.2	9
EN AC 42200 AD1	98.4	97.8	118	118	87.2	104	13.6	13
EN AC 42200 AC2	65.5	69.8	68.8	70.5	71.4	69.2	2.3	3
EN AC 42200 AB3	114	103	114	127	120	116	8.8	8
EN AC 44200 BA2	80.1	87.9	76.4	90.6	97.8	86.6	8.5	10
EN AC 44200 BD2	109	114	100	123	93.1	108	11.7	11
EN AC 44200 BC1	81	90.6	77.4	87.8	76.2	82.6	6.4	8
EN AC 44200 BB2	78.3	76.1	88.1	90.4	93.7	85.3	7.7	9
EN AC 46200 EA2	96	80.4	101	125	119	104	18	17
EN AC 46200 ED1	94.4	88.8	97	87.7	99.9	93.6	5.2	6
EN AC 46200 EC1	79.6	77	88.7	107	109	92	15	16
EN AC 46200 EB1	106	102	114	115	118	111	6.7	6

B- Acetic Salt Spray Tests

Type of Alloy	Type of process and description			
	Traditional pretreatment Chromium ISO 10546		Alternative pretreatment Chromium free	
	Standard Pretreatment Acid Etching	SEASIDE Pretreatment Type AA	Standard Pretreatment Acid Etching	SEASIDE Pretreatment Type AA
EN_AC_42200 AlSi7Mg0,6 R. 900	A-A-1	A-D-1	A-C-1	A-B-1
	A-A-2	A-D-2	A-C-2	A-B-2
	A-A-3	A-D-3	A-C-3	A-B-3
EN_AC_44200 AlSi12Cu R. 901	B-A-1	B-D-1	B-C-1	B-B-1
	B-A-2	B-D-2	B-C-2	B-B-2
	B-A-3	B-D-3	B-C-3	B-B-3
EN_AC_46200 AlSi9Cu3 R.902	E-A-1	E-D-1	E-C-1	E-B-1
	E-A-2	E-D-2	E-C-2	E-B-2
	E-A-3	E-D-3	E-C-3	E-B-3

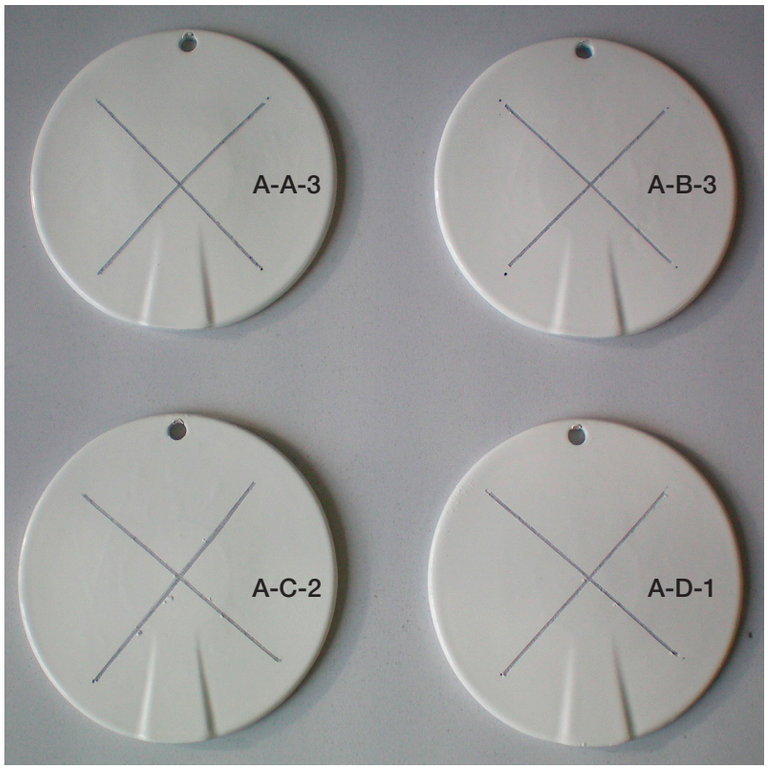
The colour in the table above gives a visual assessment of the results which are as follows:

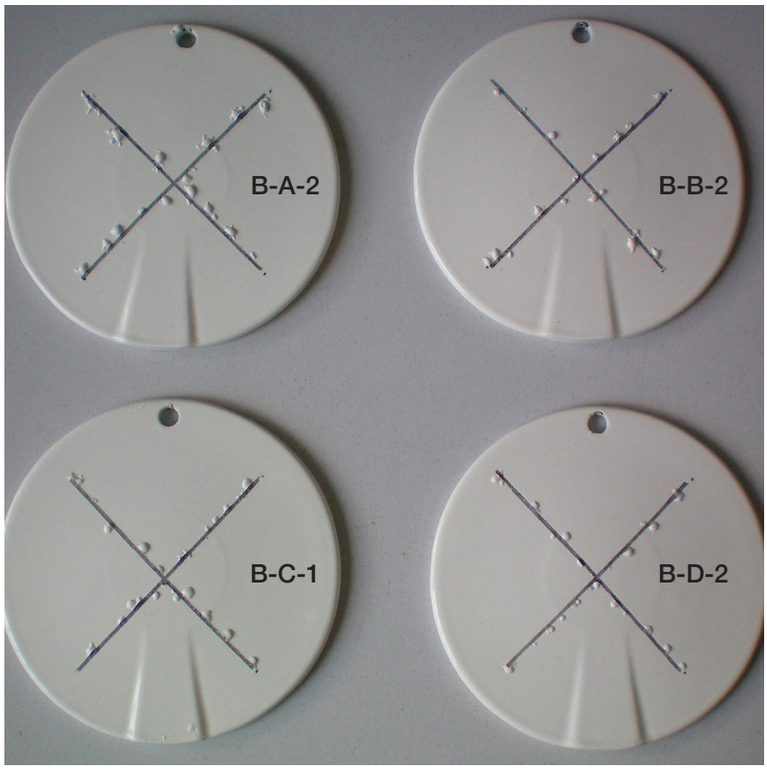
Colour	Evaluation
	Good
	Negative but not so far from the limits
	Strongly negative

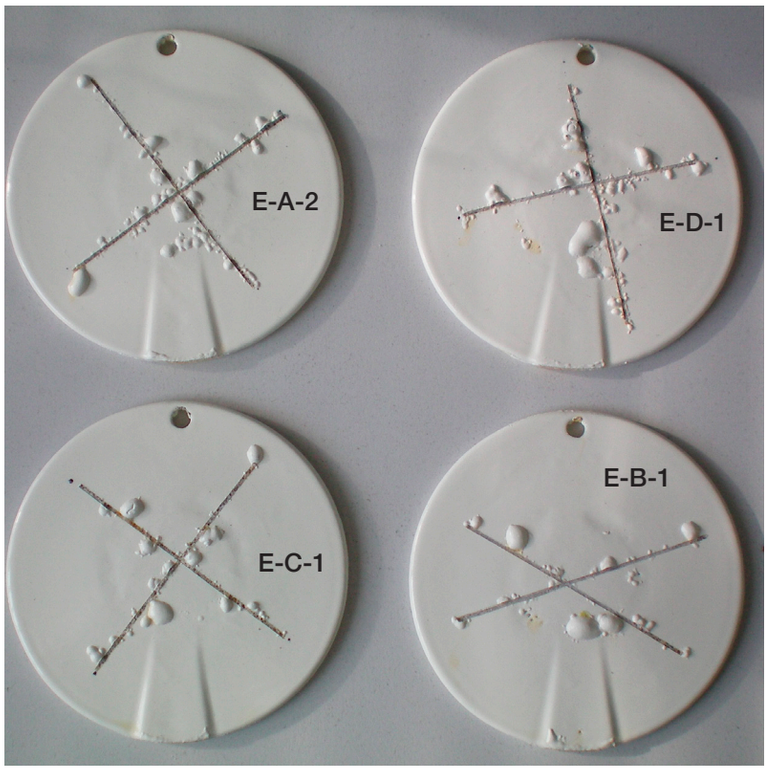
Conclusion

The results show that the presence of Copper (Cu) reduce the performance on the Acetic Salt Spray test (AASS).

Samples Tested:



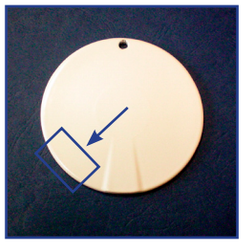

B-A-2
B-B-2
B-C-1
B-D-2


E-A-2
E-D-1
E-C-1
E-B-1

A look inside at the structure of aluminium alloy

To understand the reasons for the difference in the AASS results, it is necessary to look inside at the structure of the samples and to explore the inter-metallic compound and elements (Si) that play an important role in the corrosion process.

Coated samples of different aluminium alloys labelled as follows:

<table>
<tr><th>Type of Alloy</th><th>Description</th><th>Photo (metallographic specimen)</th></tr>
<tr><td>EN AC
42200 - Al Si
7 Mg 0,6</td><td>Cast
accessories</td><td rowspan="3"> 
Photo 1. Sample of cast accessory
Micrographic specimen – observation direction</td></tr>
<tr><td>EN AC
44200 - Al Si
12 Cu</td><td>Cast
accessories</td></tr>
<tr><td>EN AC
46200 - Al Si
9 Cu 3</td><td>Cast
accessories</td></tr>
<tr><th colspan="3">Specimen Preparation (IO-15)</th></tr>
<tr><td colspan="3">The specimens were obtained as showed in photos 1 and 2, with a section length of about 15 mm.
They were mounted in hot transparent resin and polished to up to 0.05 µm.</td></tr>
</table>

technical information

Permanent Mould and Sand Castings.
Cast Accessory – Alloy EN AC 42200 - Al Si 7 Mg 0,6

Cross-sectional examination – Optical Microscope
Chemical Etching: Hydrofluoric acid HF 0.5% 10”

		Si%	Fe%	Cu%	Mn%	Mg%	Zn%	Ti%
EN AC-42200	AB2	6.74	0.201	0.0441	0.0878	0.424	0,0623	0.108
Uncertainty		± 0.21	± 0.019	± 0.0066	± 0.0106	± 0.031	± 0.0083	± 0.012
Specification UNI EN 1706:2010 lega EN AC-42200		From 6.5 to 7.5	Max 0.19	Max 0.05	Max 0.10	From 0.45 to 0.70	Max 0.07	From 0.08 to 0.25

Notes:
- The concentration of each other element less than 0,03% and the sum of their concentrations below 0,10% (EN AC-42200).
- Uncertainty of measurement multiplied by a coverage factor k=2 (confidence level of approximately 95%).

Photo 3.

EN AC 42200
Coating Thickness = 101 µm

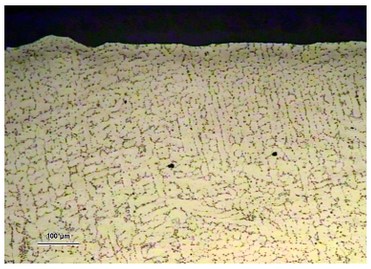


Photo 4

Micrography
EN AC 42200

Magnification 100x

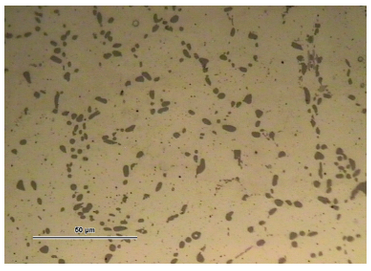


Photo 5.

Micrography
EN AC 42200

Magnification 500x

Heat treated TA. Mg_2 Si is completely dissolved by solution treatment; Si and, in a quite less measure α (Al Fe Mn Si) particles are rounded and agglomerated. Very fine precipitation of α (Al Fe Mn Si) is present on the background.

Permanent Mould Casting

Cast Accessory – Alloy EN AC 44200 - Al Si12

Cross-sectional examination – Optical Microscope
Chemical Etching: Hydrofluoric acid HF 0.5% 10”

		Si%	Fe%	Cu%	Mn%	Mg%	Ni%	Zn%	Ti%
EN AC-44200	BB1	12.56	0.570	0.0769	0.156	0.141	0.00871	0.148	0.0372
Uncertainty		± 0.33	± 0.038	± 0.0096	± 0.0166	± 0.015	± 0.00214	± 0.015	± 0.0058
Spec. UNI EN 1706:2010 alloy EN AC-44200		From 10.5 to 13.5	Max 0.55	Max 0.05	Max 0.35			Max 0.10	Max 0.15
Alloy EN AC-44100		From 10.5 to 13.5	Max 0.65	Max 0.15	Max 0.55	Max 0.10	Max 0.10	Max 0.15	Max 0.20

Note:
- The concentration of each other element less than 0.05% and the sum of their concentrations below 0.15%
- Uncertainty of measurement multiplied by a coverage factor k=2 (confidence level of approximately 95%).

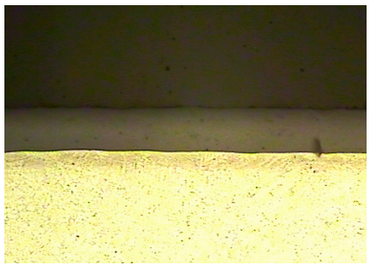


Photo 6.

EN AC 42200
Coating Thickness = 90 µm

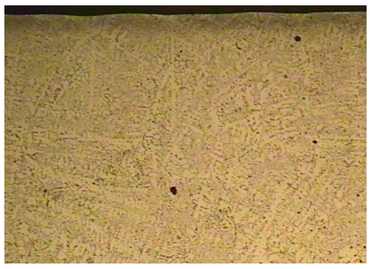


Photo 7.

Micrography
EN AC 44200

Magnification 100x

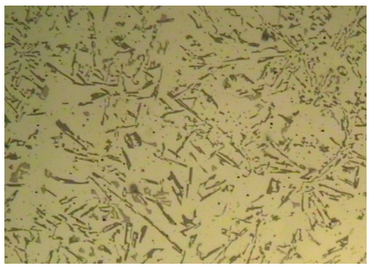


Photo 8.

Micrography
EN AC 44200

Magnification 500x

Heat treated TA, with unmodified structure. In addition to binary eutectic Si, residual particles of Si + Mg_2 Si of the original ternary eutectic a (Al) - Mg2 Si - Si, are present.

Pressure Die Casting

Cast Accessory – Alloy EN AC 46200 - Al Si 8 Cu 3

Cross-sectional examination – Optical Microscope
Chemical Etching: Hydrofluoric acid HF 0.5% 10”

		Si%	Fe%	Cu%	Mn%	Mg%	Ni%	Zn%	Ti%	Pb%	Sn%
EN AC-46200	EB3	9.23	0.708	3.12	0.148	0.101	0.0838	0,851	0.0621	0.0621	0.020
Uncertainty		± 0.26	± 0.045	± 0.12	± 0.015	± 0.012	± 0.0102	± 0.051	± 0.0067	± 0.0083	0.004
Specification UNI EN 1706:2010 alloy EN AC-46200		From 7.5 to 9.5	Max 0.8	From 2.0 to 3.5	From 0.15 to 0.65	From 0.05 to 0.55	Max 0.35	Max 1.2	Max 0.25	Max 0.25	Max 0.15

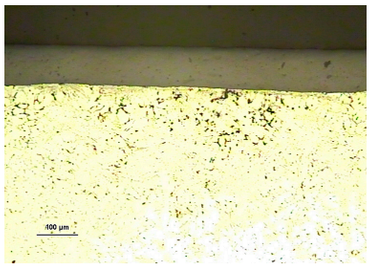


Photo 9.

EN AC 46200
Coating Thickness = 103 µm

Photo 10.

Micrography
EN AC 46200

Magnification 100x

Photo 11.

Micrography
EN AC 46200

Magnification 500x

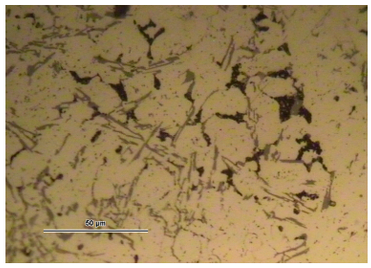


Photo 12.

Micrography
EN AC46200

Magnification 500x

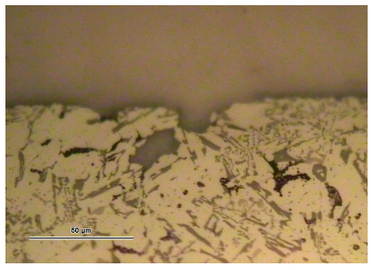


Photo 13.

Micrography
EN AC46200

Magnification 500x

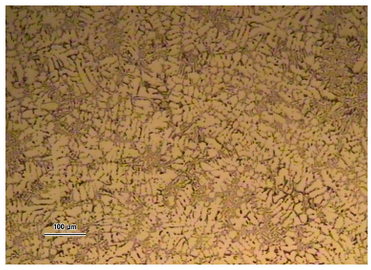


Photo 14.

Micrography
EN AC 46200

Magnification 100x

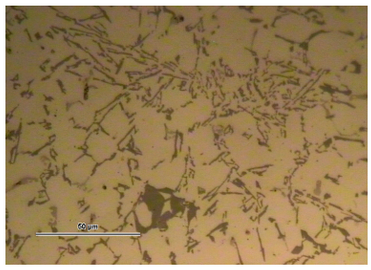


Photo 15.

Micrography
EN AC 46200

Magnification 100x

Typical structures consisting essentially in α (Al) dendrites and eutectics containing Si, Cu Al2, Al7 CU2 Fe, on parts of the castings having different thickness. Rare needles and oxide inclusions.

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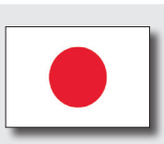

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