



# **Corrosion-resistant MAO coatings of MANEL on aluminum alloys**





JSC MANEL is innovative company,

Occupied by:

- Development of MAO coatings
- production of MAO coatings for various purposes on the parts of aluminum, titanium and magnesium alloys
- Production of equipment for microarc oxidation technology (MAO)



- **Building industry**
- **Mechanical engineering**
- **Instrument making**
- **Car industry**
- **Ship industry**
- **Air craft industry and space**
- **Medicine**



MAO MANEL – is an electrochemical surface treatment process. It is closed to Anodization.



Distinctive feature of the process is participation the micro arc discharges in the coating formation process. As result composition and structure of the MAO-coatings differ from anodic coatings essentially.

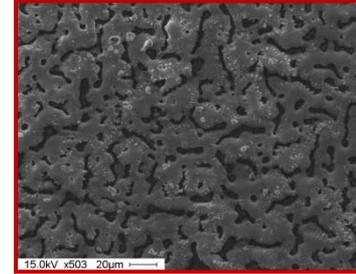
Depending on the mode of microarc oxidation and electrolyte composition it is possible to produce ceramic coatings with unique characteristics and a wide spectrum of application.

### Transition layer

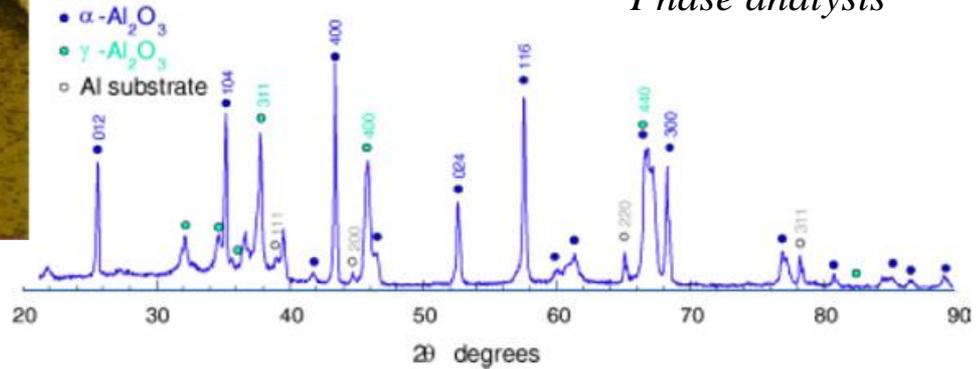
Nonporous layer, which limits access to the corrosive medium the metal-coating and offset load thermal cycling effects  
Composition:  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>,  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>  
Thickness: 5 - 20  $\mu$ m.  
Microhardness - 500 - 2200 HV

### Based layer

Porosity of the coating - 5-30%  
Composition:  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>,  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>, the components of the electrolyte  
Thickness: 20 - 40 microns  
Hardness: 600 - 1000 HV



*X-ray diffraction  
Phase analysis*

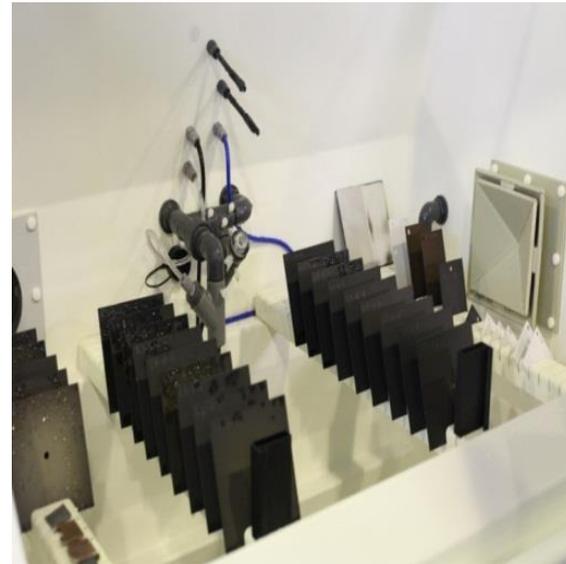


MANEL coating is thin porous ceramics of complex structure with unique properties

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## **Equipment of MANEL laboratory for corrosion testing of MAO-coating**



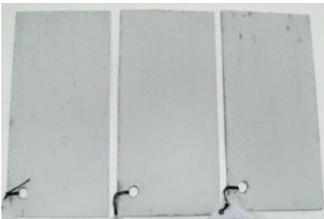
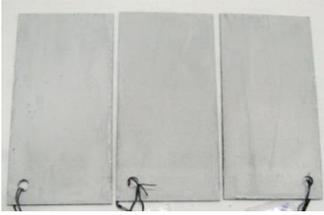
All tests of the samples were carried out in a chamber of salt fog Ascott CC450.



## The MAO coatings on EN AW-5251 alloy before and after corrosion tests

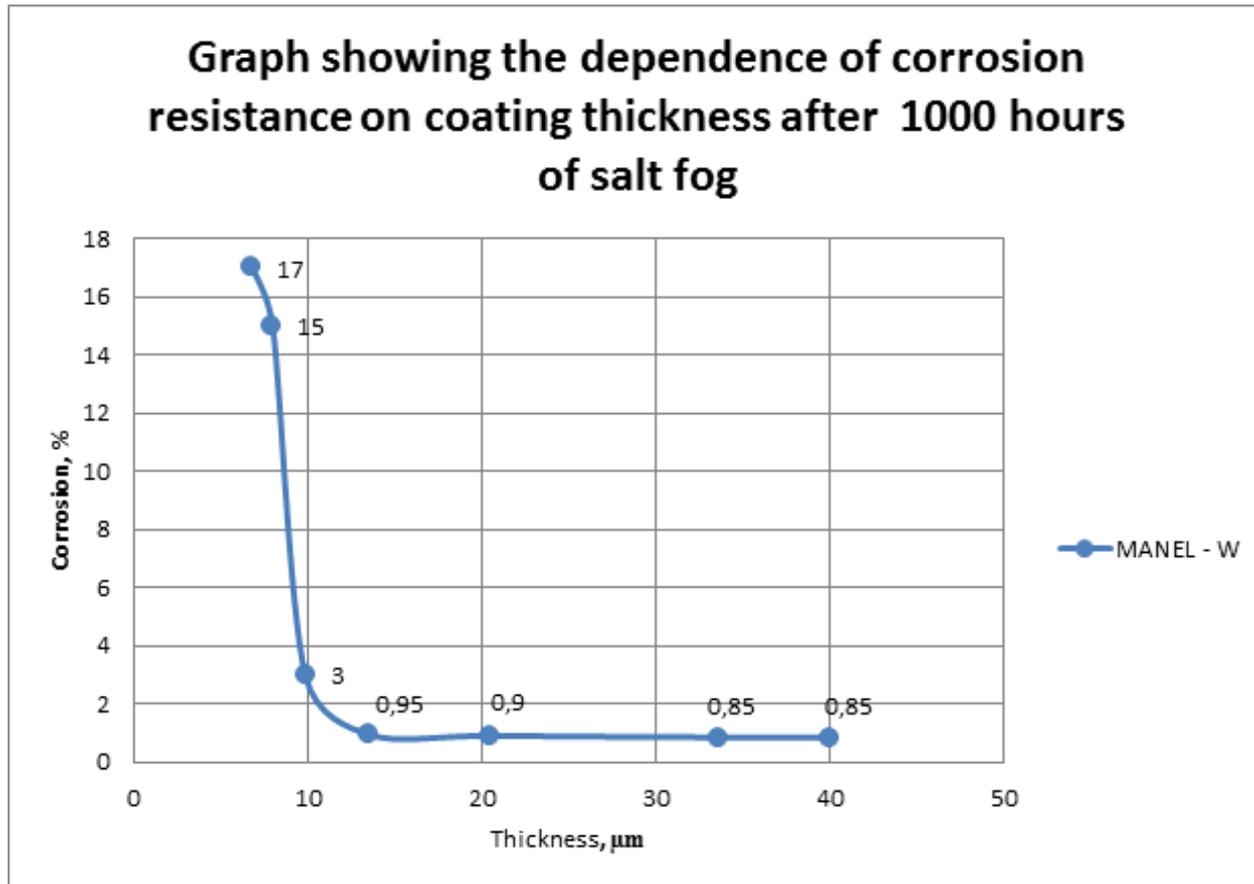
MAO-Coatings MANEL	Appearance of samples before testing	Appearance of samples after testing
MANEL - W	 A circular, dark grey/black sample with a small hole at the top, appearing smooth and uniform in color.	 A circular, dark grey/black sample with a small hole at the top, showing some surface texture and slight discoloration after testing.
MANEL - B	 A circular, light grey/white sample with a small hole at the top, appearing smooth and uniform in color.	 A circular, light grey/white sample with a small hole at the top, showing some surface texture and slight discoloration after testing.



Alloy and coating thickness	Appearance of samples before testing	Appearance of samples after testing	Number of hours
EN AW-7075, 10 $\mu\text{m}$			480
EN AW-7075, 40 $\mu\text{m}$			480
EN AW-2024, 10 $\mu\text{m}$			100
EN AW-2024, 40 $\mu\text{m}$			1000



# Corrosion resistance of MAO coatings MANEL depending on coating thickness





## Results of MAO-coatings MANEL tests on mushroom resistance

№	Type of MAO-coating MANEL	Sample material, aluminum alloy	Appearance of coatings after testing	Score in accordance with GOST 9.048-89
1	Black	EN AW-2024	Under a microscope: spores of spores and conidia are not found	0
2	White	EN AW-2024	Under the microscope: spores of spores and conidia are not found, on the surface are traces of the suspension	0
3	White	EN AW-5251	Under a microscope: sprouted spores and slightly developed mycelium	1
4	White	EN AW-2024, impregnation of coating by PTFE	Under a microscope: spores of spores and conidia are not found	0
5	White	EN AW-2024 impregnation coating by Cramolin Urethane	Under the microscope: sprouted spores of mushrooms	1

All investigated "Manel" coatings of the type tested for mushroom resistance in accordance with GOST 9.048-89 passed the test.



## Comparison of based coating properties MAO MANEL and Anodization

<b>Properties</b>	<b>MAO MANEL</b>	<b>Anodization</b>
Thickness, $\mu\text{m}$	150	60
Corrosion resistance, salt spray , hours	2000	500
Microhardness, HV	2200	500



## Comparison MAO MANEL and Anodizing

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### Anodizing operations

Degreasing

Rinsing

Etching

Rinsing

Brightening operation

Rinsing

### **ANODIZING**

Rinsing

Thickening

Coloring

Rinsing

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### MAO operations

Degreasing

Rinsing

### **MICRO ARC OXIDATION**

Rinsing





## Application of MAO-coatings MANEL for corrosion protection

### Sublayer for subsequent polymer staining:

The coating thickness is 5-15  $\mu\text{m}$

Provides adhesion of polymeric materials  
in accordance with GOST 15140-78

Corrosion resistance in salt fog 720 hours



## Application of MAO-coatings MANEL for corrosion protection

### **Black coating for optical instruments:**

Coating thickness 40  $\mu\text{m}$

Degree of blackness - 0.94

Corrosion resistance in salt fog 1000 hours





## Application of MAO-coatings MANEL for corrosion protection

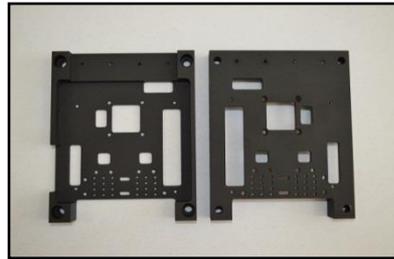
### For Instrumentation industry

Protective-decorative coatings

Coating thickness 20 - 70  $\mu\text{m}$

Corrosion resistance in salt fog 1000 hours

Coatings on alloys: EN AW-2024, EN AW-5251, EN AW-5356, EN AW-3003, EN AW-6063, EN AW-7075 and cast alloys 355.0, 357.0, A13600, A14130



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**Thank you  
for your attention!**

