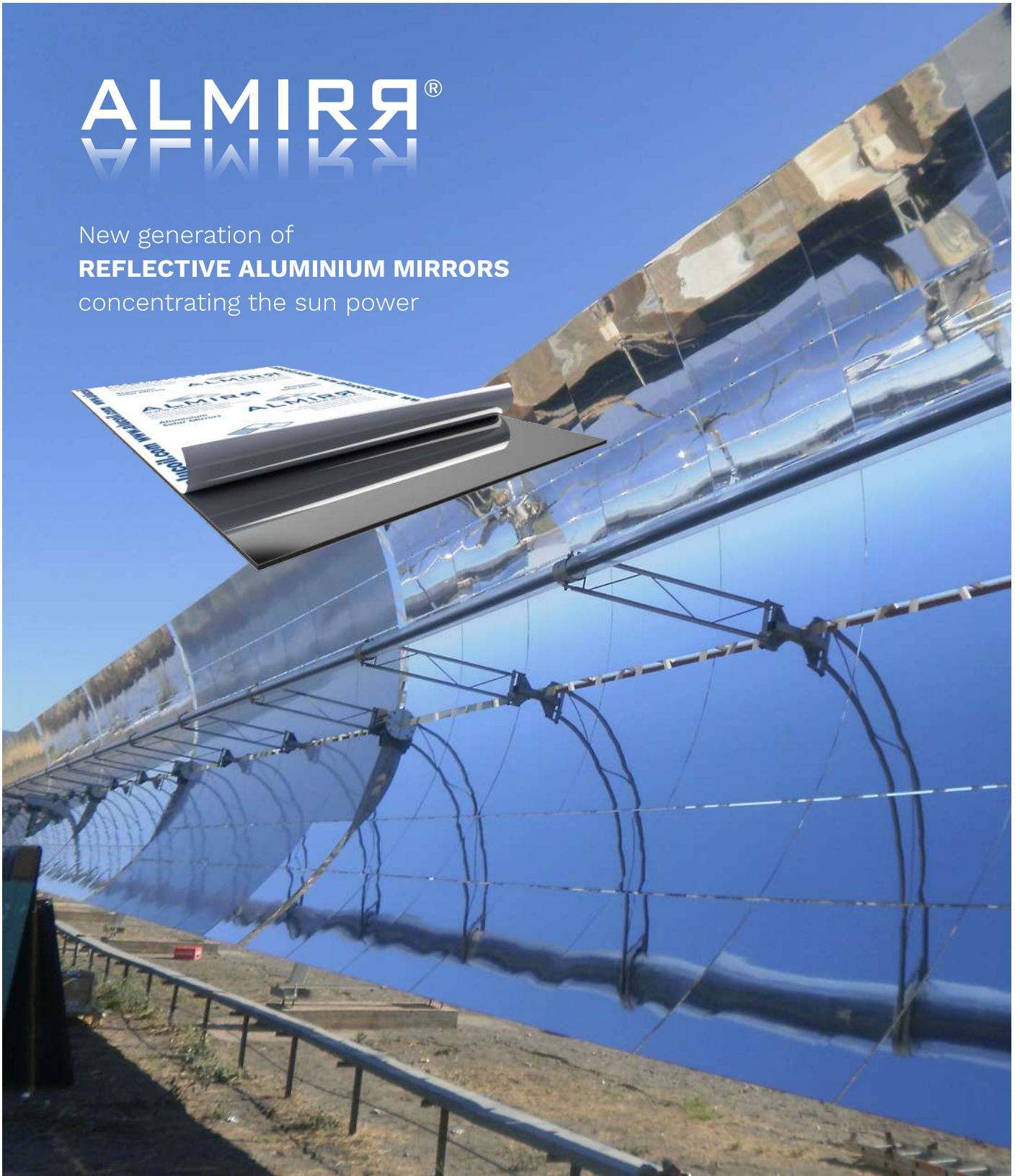


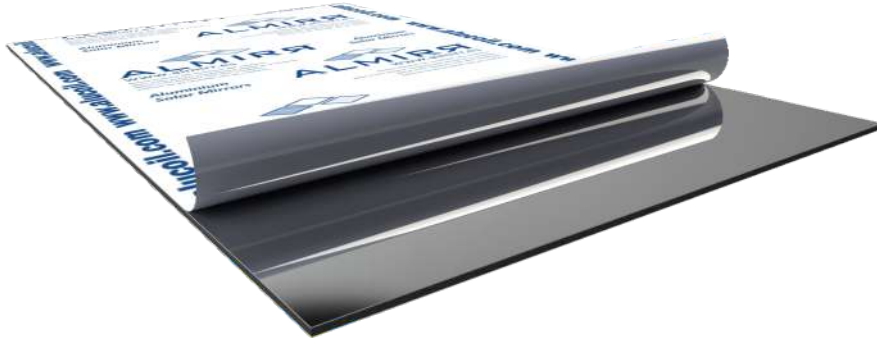
# ALMIRÁ<sup>®</sup>

New generation of  
**REFLECTIVE ALUMINIUM MIRRORS**  
concentrating the sun power



MANUFACTURER OF ADVANCED MATERIALS

# ALMIRR<sup>®</sup>



## MULTILAMINAR ALUMINIUM MIRRORS FOR CONCENTRATED SOLAR POWER

**Alucoil<sup>®</sup>**, manufacturer of semi-transformed aluminium products, has developed a new generation of multilaminar aluminium mirrors.

**almirr<sup>®</sup>** is formed by two 0,3 mm thickness aluminium sheets and a core of plastic resins, which give the product an extraordinary rigidity. The front side (the specular one) is formed by a high reflective aluminium sheet alloy of 99.9 % purity. This side has a special treatment based in aluminium salts PVD layer protected with a ceramic coating resistant to abrasion and finally includes a removable protective PVC film that prevents small damage during the handling.

After a long time now, the industry of concentration of solar energy is demanding products to improve the energy efficiency of the power plant in order to make this technology profitable in commercial terms. **almirr<sup>®</sup>** achieves, due to its excellent optical and technical properties, important advantages that result in considerable cost reductions.

**almirr<sup>®</sup>** perform a perfect function as reflective surface in high and medium temperature solar thermal concentrators and concentrated photovoltaic systems. They combine a high reflection level of 88% (spectrum AM 1.5), with good properties of lightness, stiffness, resistance to shocks and abrasion, ease of handling, transportation and installation.

**almirr<sup>®</sup>**'s ease of handling, excellent flatness and bending properties makes it perfectly suitable for cylindrical parabolic trough collectors, central receiver systems, linear fresnel reflector systems, stirling disk and concentration photovoltaic systems. **almirr<sup>®</sup>** represent an important saving in handling and installation time, with respect to traditional glass mirrors.

### Advantages of **almirr<sup>®</sup>**.

- Abrasion and high corrosion resistance, increase the life of the material.
- Length up to 6000 mm and width up to 1250 mm.
- More shock resistance, which implies fewer replacements for breakage.
- Installation, easier handling, lower costs.
- Reduction of weight.
- Reduction of transport and packaging cost.



Innovacion Medioambiental (Almeria)

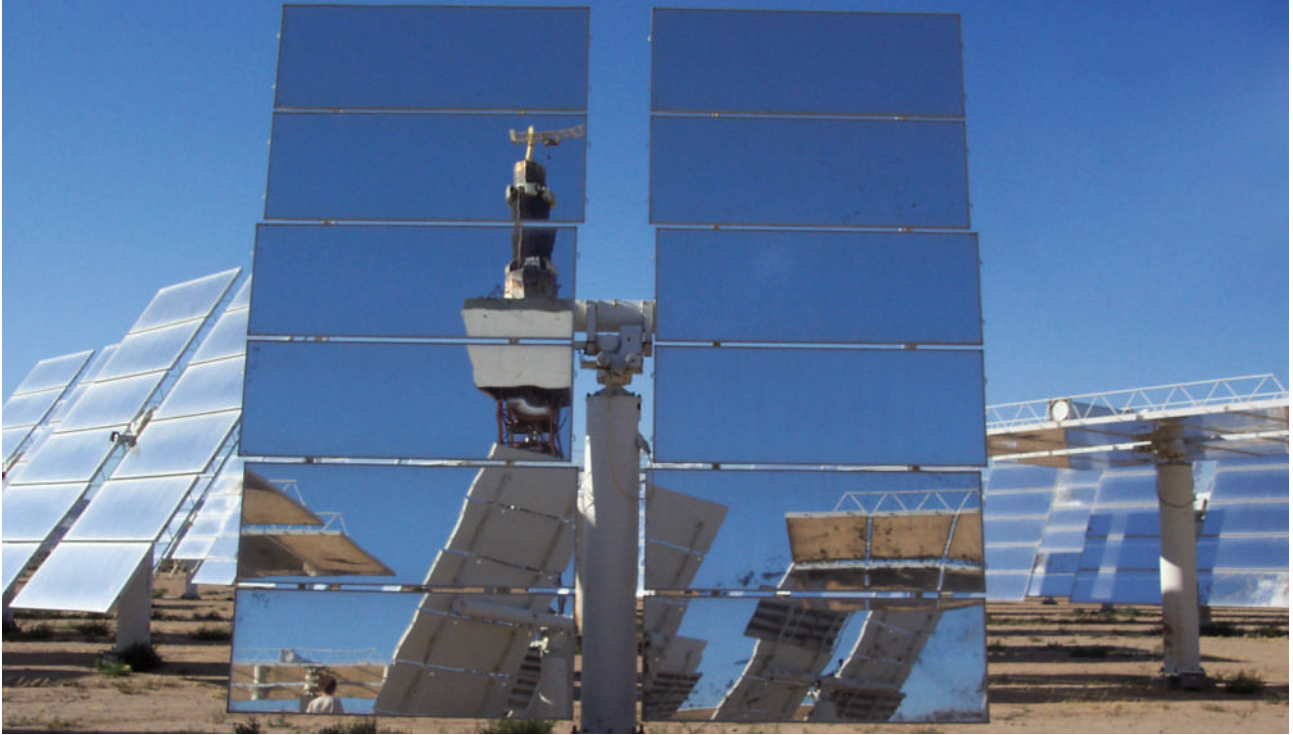


Disco Stirling (Reus)



Stirling Trinum (Italia)

# ALMIRЯ®



## OPTICAL PROPERTIES

Multilaminar aluminium mirrors **almirr®**, consist of two aluminium sheets and a plastic resin core. The reflective front side is made up of a PVD (Physical Vapour Deposition) aluminium salt layer, coated over a 0,3 mm thickness aluminium sheet. This side is covered by a ceramic protective coating, for outside use. The back side is protected by a polyester paint coating.



Removable protective film  
Ceramic protective coating  
PVD treatment  
Anodized layer  
Aluminium sheet  
Anodized layer  
Adhesive  
Plastic resins core  
Adhesive  
Aluminium sheet  
Polyester paint coating

**MIRO-SUN®**

## OPTICAL VALUES

		STANDARDS
Total light reflection (%)	≥92	DIN 5036-3 (U-Globe) (8°)
Brightness 60° along	≥87	ISO 7668 (60°)
Brightness 60° across	≥87	ISO 7668 (60°)
Solar reflection (%)	≥90	ASTM G 173
Solar weighted spec. reflectance (%)	≥84	ASTM G 173

## MECHANICAL PROPERTIES

Multilaminar aluminium mirrors, **almirr®** have a plastic resin core, and are available in four different thicknesses:

- **almirr® 203**: 2 mm thick.
- **almirr® 303**: 3 mm thick.
- **almirr® 403**: 4 mm thick.
- **almirr® 503**: 5 mm thick.
- **almirr® 603**: 6 mm thick.

Aluminium reinforced with plastic resins makes it lightweight, but also extremely shock- and handling-resistant.

	203	303	403	503	603	Standards
Moment of inertia <sup>(*)</sup> "I" (mm <sup>4</sup> /m)	438	1117	1801	2847	4403	DIN 53293
Rigidity <sup>(*)</sup> "EI" (kNcm <sup>2</sup> /m)	307	782	1261	1993	3082	DIN 53293
Section modulus <sup>(*)</sup> (mm <sup>3</sup> /m)	438	744	901	1138	1468	DIN 53293
Thermal resistance <sup>(*)</sup> "R" (m <sup>2</sup> K/W)	0,005	0,0205	0,0190	0,0169	0,0315	UNE 92-202-89-1989
Thermal conductivity <sup>(*)</sup> "λ" (W/mK)	0,40	0,175	0,221	0,296	0,204	UNE 92-202-89-1989
Thermal expansion "α" (mm/m Δ100°C)	2,3					

<sup>(\*)</sup>Estimated values while lab results arrive

## RESISTANCE TESTS

### 1. Abrasion Test

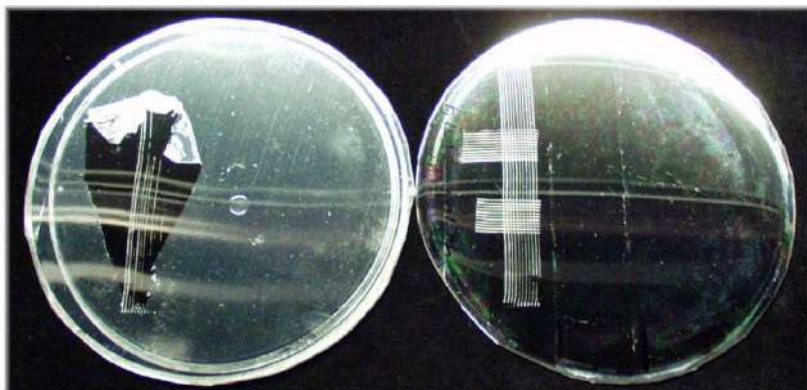
The sample MIROSUN® showed excellent abrasion resistance with out damage after the abrasion test. This result means that they can clean the surface with a cloth or other tissue without fear of damaging the highly reflective surface.

### 2. ΔT-TEST

The test is described in DIN 50 928. It is only carried out on the external reflective aluminium sheet, in order to study the "ceramic protective coating" adhesion.

Circular samples with a diameter of 118 mm were fixed in a special holder under tension. With the help of a pump, the front side was covered in 42 °C warm water, and the rear side with 35 °C water. The test was carried out for 168 hours. Afterwards, the sample was visually inspected to see if the lacquer adhesion of the sample was damaged or not. Additionally, Tesa tape was applied to a cross-cut grid and then removed to see if any of the lacquer squares were removed together with the tape removal.

The main goal of this test is to measure the adhesion and delamination of the lacquer, in condensation and humidity conditions, with differences in temperatures between the reflective and the rear side.



### 3. Resistance to Boiling Water

A further adhesion test is the heat resistance test; the test followed the guidelines issued by GSB (The German Quality Association for the Piecework Coating of Aluminium Components). In this case, the adhesion of the lacquer was tested in a humid environment. This test is a very sound quick test, where the simulated conditions are much more intense in comparison to the actual situation in practice. If the sample passes this test, very good adhesion characteristics can be testified.

MIRO-SUN® passed the heat test without defects. Lacquer delamination is not observed. Apart from the exceptional bonding characteristics it has become obvious that even after a 72 hour bath in the red colour the lacquer shows no signs of red discoloration. This indicates that the lacquer is not porous and does not absorb the red dye.

### 4. UV-C Test in desalinated water

It is the purpose of this study to assess the stress of lacquered surfaces under Uvlight and, at the same time in a humid environment. It is based on the assumption that TiO<sub>2</sub> tends to show photo catalytic behaviour which could lead to delamination of the lacquer.

The MIRO-SUN® shows no damage or delamination with the UVC test in desalinated water.

### 5. Bend test

The bending test is carried out in accordance with DIN EN ISO 1519 and tests the adhesiveness of the lacquer in the area of the bend.

Since the lacquer for MIRO-SUN® is very hard, only bending with the good side outside with an inside diameter of curvature of 2 mm and with the good side inside with a diameter of 14 mm can be withstood whereas with a smaller diameter of curvature of 6 mm (good side inside) occasionally damage to the lacquer layer is to be observed. The final users of the material can therefore bend the material good side outside without worry, whereas bending with the good side inside needs to have a minimum diameter of inside curvature of approximately 14 mm.

### 6. Lacquer Limit During Forming With MIRO-SUN®

The quality side of MIRO-SUN® (material thickness 0.5 mm) was tested for compressive and tensile load on different bending radio.

The test results show, that MIRO-SUN® (material thickness 0.5 mm) can be bended to a minimum radius of 50 mm without cracks in the protective coating. The approved bending radii for MIRO-SUN® (material thickness 0.5 mm) are bending radius  $\geq$  50 mm for compressive and tensile load.

### 7. Salt-Spray-Test

The salt-spray-test is done according to DIN EN ISO 9227 NSS.

MIRO-SUN® Generation II passes 3000 h salt-spray-test. After this time, the total light reflection Y (D 65) decreases by less than 0.5% and the diffuse light reflection rho\_d increases by less than 2%. MIRO-SUN® generation II shows no pitting corrosion, which would show-up visibly with white run-off traces.

### 8. QCT-Test

For the QCT-test the QCT Weathering Tester by Q-Lab is used. Our QCT-test fulfills the DIN EN ISO 6270-2 –Part 2. All samples are measured before and after the exposure in the QCT with Minolta and integrating sphere. Additionally to the optical values, the visual impression of the samples is being used to judge corrosion.

MIRO-SUN® passes 3000 h QCT-test. The total light reflectivity Y (D 65) is reduced by less than 0.5% and the diffuse light reflectivity rho-d does not increase by more than the error of measurement. No pitting corrosion can be observed after QCT exposure, neither any other type of corrosion. The visual impression after the test is equivalent to before the test. QCT Weathering Tester (left) and MIRO-SUN®-samples during the test (right)

### 9. Impedance spectroscopy

For the impedance spectroscopy a potentiostat PARSTAT 2273 is used.

The improved barrier properties lead to a better outdoor stability of MIRO-SUN®.

### 10. Outdoor testing

Alanod frequently tests MIRO-SUN® at different locations around the globe under real outdoor conditions. Emphasis is usually on maritime climate since the proximity to sea waters expose the material to a salt laden climate. In this document we exhibit our results for outdoor exposure in Mytilini, isle of Lesbos, Greece. Samples of both generations of MIRO-SUN® were exposed simultaneously for 13 month in this rather extreme climate.

While MIRO-SUN® generation II shows only minimal defects. and in outdoor exposure in a maritime climate, in a hot and dry climate, and in a typical industrial environment good corrosion stability. Compared to conventional transparent corrosion protection lacquers the results are very good.

## AVAILABILITIES

MULTILAMINAR ALUMINIUM MIRRORS **almirr®**, are cut and provided depending on the project and application, in different thicknesses.

	Total thickness	Weight	Length	Width
<b>almirr® PE 203</b>	2 mm	3,04 kg/m <sup>2</sup>	Up to 6000 mm	Up to 1250 mm
<b>almirr® PE 303</b>	3 mm	3,94 kg/m <sup>2</sup>		
<b>almirr® PE 403</b>	4 mm	4,84 kg/m <sup>2</sup>		
<b>almirr® PE 503</b>	5 mm	5,74 kg/m <sup>2</sup>		
<b>almirr® PE 603</b>	6 mm	6,64 kg/m <sup>2</sup>		



# ALMIRRA®



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