

## Introduction

The profitability of concentrating solar power plants (CSP) is conditioned by the durability of solar reflectors because of their main function to reflect solar radiations towards receivers. But operating sites undergo different climatic aggressions like wind, sand storms and rainfall which weaken reflectors over time. So the durability study and the lifetime prediction of solar mirrors is very important.

The lifetime of solar mirrors is conditioned by several factors:

- Exposure conditions: Inclination angle, Orientation after the cardinal points... ;
- Environmental conditions: Irradiation, Temperature, wind sand storms, snow...;
- Nature of mirrors: glass mirrors, polymeric mirrors, aluminum mirrors...;
- Manufacturing process of coating: anti-soiling, hard coating...;
- Protective back side coatings.

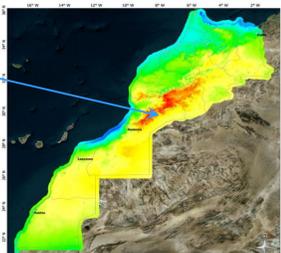
This work aims to study the effect of orientation and inclination on the solar reflectors durability in correlation with wind speed and direction by an outdoor exposure in a desertic site.

## Experimental study

### Outdoor sites properties



Desertic (Ouarzazate)



Geographic localisation of Ouarzazate site



Exposure rack

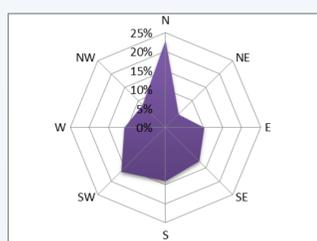
- Mirror samples are exposed on a special erosion rack with varying inclination angles (0°, 45°, 90° and 135°) and facing two different directions (North and South) in order to evaluate the effect of the wind direction and inclination angle on the mirrors degradation.

### Environmental parameters

- To make correlations between the environmental data and the degradations observed on the solar mirrors the meteorological data are collected during the entire period of exposure thanks to a weather station implemented on the site.



Meteorological station in Ouarzazate site

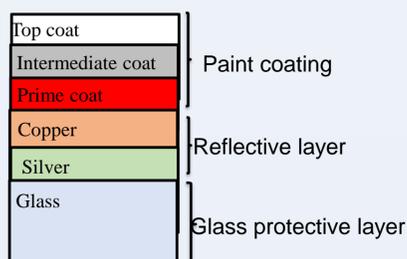


Wind direction in Ouarzazate site

- Dominant winds are arising mostly from the north direction.
- The mean wind speed is around 3.08 m/s.
- The maximum wind speed reached is around 25 m/s which transport dust by suspension in the air to the surface of the reflectors and consequently provoke its soiling and/or erosion and create cleaning difficulties.

### Studied samples

- Tested samples are glass solar mirrors with a silver reflective layer and a size of 10X10 cm. Two different samples from two suppliers were exposed for comparison (RLA1 and RLB1).



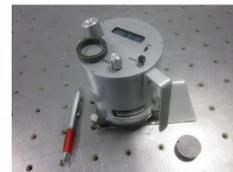
The structure of Studied samples

	RLA1	RLB1
Glass thickness (mm)	2	1
Exposure duration (Months)	31 months	19 months
Initial specular reflectance	95.96	96.58

Exposed samples properties

### Measured parameters

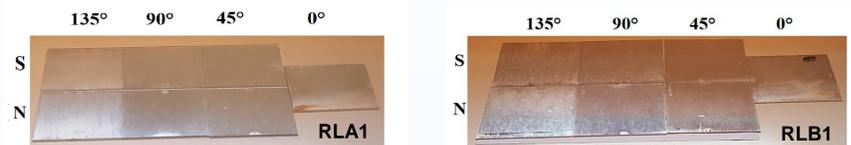
- Optical degradation of samples are measured by a portable reflectometer on the site.



15R-USB portable specular reflectometer

## Results

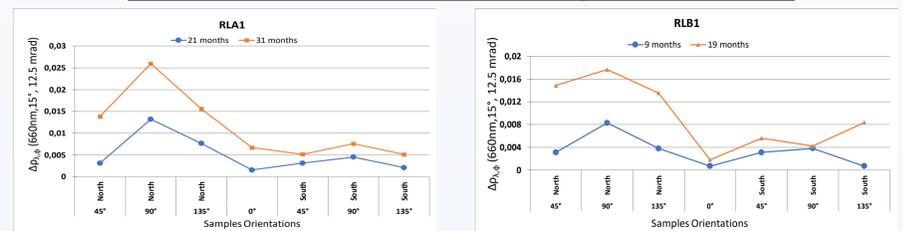
### Effect of samples inclination on soiling deposition



General aspect of tested samples before cleaning

- The samples exposed with an inclination angle of 135° present the higher soiling deposition for both samples because this inclination is closest to the ground and since the mean wind speed is around 3 m/s so the small particles of sand will quickly stick to the samples inclined at 135°.

### Effect of samples inclination on optical degradation properties



Specular reflectance loss for RLA1 and RLB1 samples exposed according to different exposure conditions in Ouarzazate site

- For Both samples, the highest reflectance loss is recorded for the samples exposed facing the north direction and at 90° inclination which is correlated with the meteorological data recorded.
- For RLA1, the maximum loss reached is around 2.6 % for north direction and 0.8% for south direction after 31 months of exposure.
- For RLB1 samples the maximum loss reached is around 1.8 % for north direction and 0.8% for south direction after 31 months of exposure.
- The RLB samples' global behavior is similar to the one of the RLA samples and the variation tendency between the north and the south remain the same for both of them.



Optical microscopy images of impacted surface of RLA1 and RLB1 samples exposed according to north direction in Ouarzazate site

- The majority of degradations observed for these two samples corresponds to erosion

## Conclusions

- Meteorological conditions of the site have a great impact on solar mirrors durability, especially wind speed and direction,
- For this site and for the studied period the maximum wind speed reached is around 25m/s which transport fine particles of sand by suspension in the air to the surface of the reflectors and consequently provoke its soiling,
- The greatest losses in reflectance are observed in the north orientation and the inclination 90 °,
- Erosion and soiling deposition are the most observed degradation at Ouarzazate site.