









THE IMPORTANCE OF DEVELOPING ACCELERATED CORROSION TESTS ON THE RELIABILITY OF SOLAR ABSORBER AND SOLAR REFLECTOR COATINGS

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ABSTRACT

Selective absorber coatings for solar thermal collectors and reflector coatings for Concentrating Solar Power (CSP) plants are the key components of these technologies and their durability is one of their most important characteristics. They should be low cost and withstand 20-30 years under different kinds of environments without significant loss of optical performance.

Commercially, there are different physical vapour deposition (PVD) coatings for aluminium absorbers and reflectors. Results obtained with two commercial PVD solar absorber coatings (SA) and two solar reflector coatings (SR), under different accelerated aging tests (AAT), are presented and correlated with outdoor exposure. An Outdoor Exposure Testing (OET) site with maritime and industrial influence was used for an exposure campaign of the absorbers and reflectors for two years.

Alternative artificial aging tests are proposed for absorbers and reflectors that better reproduce the corrosion mechanism obtained in natural conditions with maritime and industrial influence. The characterization of the coatings and degradation mechanisms of different aluminium absorbers and reflectors were evaluated optically, morphologically and chemically.

The results obtained in an atmosphere with high corrosivity as in marine and/or industrial areas are a reliable way to verify the corrosion resistance of new materials in a short time and are a valuable tool to validate the different methodologies of accelerated aging tests.

Keywords: Atmospheric corrosion, Durability, Solar reflectors, Solar absorbers, Accelerated aging test

1. INTRODUCTION

The lifetime of the new materials is most relevant to ensure that the solar energy technologies are economically viable. Solar coatings have to withstand stress conditions like high temperatures, high humidity, ultraviolet irradiance or wind and snow loads depending on the geographic position and atmospheric corrosivity [1], [2]. The degradation mechanisms in different environments need to be previously evaluated. For qualification of new materials and products with respect to corrosion resistance therefore accelerated corrosion tests generally need to be adopted during product design work. The higher the degree of acceleration of a corrosion test the more favourable the accelerated corrosion test will be in keeping the required testing time short. On the other hand, the greater the acceleration of the corrosion process needs to be during the test, more difficult is to simulate properly the natural occurring corrosion processes. This is pointing to the main problem in designing meaningful accelerated corrosion tests for product qualification. Large efforts have been made to




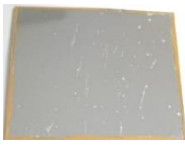


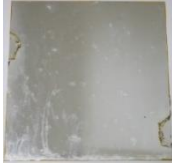

develop accelerated corrosion tests for the purpose of product qualification and corrosion resistant levels.

To study the durability of selective solar absorber coatings and solar reflectors, two alternatives were considered. One is to study their durability on an outdoor exposure test site and, the other is to develop accelerated aging test procedures in which the stress levels of one or more degradation factors are kept higher relative to in-use conditions. The study of the durability of different selective solar absorber coatings in natural exposure was already performed and published by the authors [3], [4] and is an important knowledge for the optimization of accelerated aging tests to be applied for qualification in terms of durability of the different solar absorber [5] and reflector coatings.

2. DESCRIPTION

Absorber and reflector coatings were evaluated in different accelerated aging tests with different contaminants and in outdoor exposure for 2 years. Table 1 shows the images of two selective absorbers and two reflectors with PVD coatings after the exposure on an outdoor exposure test site for 2 years and after the exposure in an alternative accelerated aging test (AAT) with the best correlation with natural exposure. For both materials, the AAT includes a cyclic variation of corrosion promoting gases (NO₂ and SO₂), high humidity, salt spraying and drying. For reflectors, it includes additional exposure to UV radiation.

Table 1 – Photographic records of solar absorbers (SA) and solar reflectors (SR) after exposure in alternative accelerated aging tests (AAT) and in outdoor test site (OET) in Sines

	SA_1	SA_2	SR_A	SR_D
AAT				
OET				

All the coatings were characterized before and after each accelerated aging test in terms of optical properties, solar absorption and emittance for absorbers, hemispherical and specular reflectance for reflectors, and morphological and chemical changes by SEM/EDS. Based on the degradation mechanisms of the absorbers and reflectors gathered from outdoor exposure tests and accelerated aging tests, new methodologies are proposed and validated for absorbers and reflectors.

3. CONCLUSIONS

Cyclic variation of corrosion promoting gases, high humidity, salt spraying and drying seems to be an alternative aging test that reflects the different environments to which the solar thermal collectors are exposed. For reflectors, a good correlation is also obtained with the same cyclic conditions but

with the inclusion of exposure to UV radiation. It is also shown the importance of reference outdoor sites with well-defined atmospheric corrosivity in the pre-normative research work for solar systems to support the validation of the accelerated test that allows giving guarantees of materials durability.

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