



## CP2

### CORROSION AND ANTICORROSIVE PROTECTION BY PAINTING OF ALUMINUM ROLLING STOCK

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#### ABSTRACT

Due to its characteristics, aluminum and its alloys have been widely used in the manufacture of high-speed rolling stock. The series 4000 (Alfa Pendular service), manufactured by Fiat Ferroviaria (current Alstom), have aluminum alloy case structure, highlighting the 6082 alloy due to its good formability, with applications at structure level [1]. In operation since 1999, they are subjected to reactive maintenance and planned maintenance. Regarding maintenance related to the corrosion protection of structures, it is of particular importance to develop an appropriate specification and ensure that all tasks, with particular emphasis on those associated with surface preparation and corrosion protection by painting, are performed in accordance with improved practices to ensure longer service life. In addition to the conditions inherent to the service, the vandalism to which the material is subjected, foreign bodies that cause mechanical damages, various atmospheric conditions with environments of different categories of corrosivity, as well as accumulation of water/condensates or cleaning products/graffiti removers, are factors that contribute to the degradation of the material.

**Keywords:** Rolling stock, Aluminum, Anticorrosive protection, Degradation, Corrosion

#### 1. INTRODUCTION

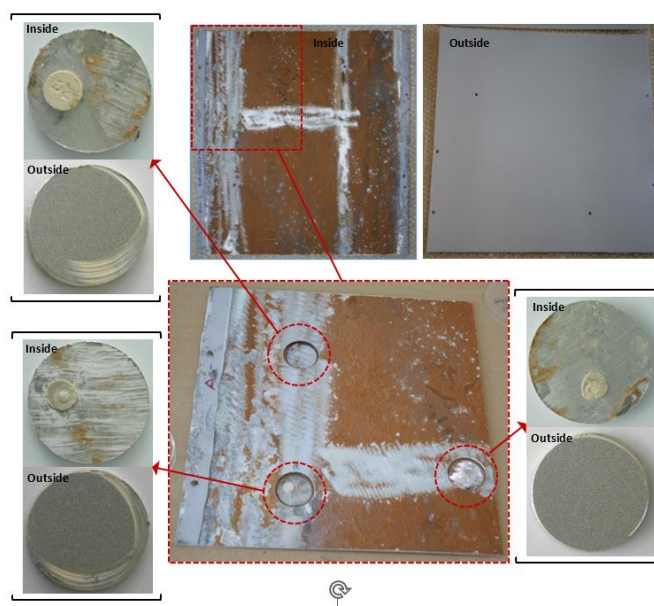
The elaboration of a specification appropriate to the state of the structures to be maintained is a prerequisite for maintenance work and determinant of its result. It should consequently be based on a specialized assessment of the overall state of the existing paint scheme and of the substrate, to foresee the application of corrosion protection schemes and auxiliary products (e.g., bitumen) appropriate to the conditions where the material will operate and compatible with each other and with the preexisting scheme, as well as to specify good working practices to be fulfilled throughout the maintenance process.

The present work is part of a study requested by EMEF – Empresa de Manutenção de Equipamento Ferroviário, S.A. to LNEG for diagnosis and analysis of the paint corrosion protection of Alfa Pendular trains, which highlights a fraction of the study performed on one driving cabin door of a unit intervened during the major review.

## 2. DESCRIPTION

In the technical visits carried out to observe the corrosion protection problems outside the trains after the first maintenance, phenomena of interstitial and filiform corrosion were identified, as well as blisters near the doors and windows (having been observed defects in seals that did not seem to guarantee required watertightness), ventilation grilles and lower carriage areas (corrosion from the edges) and cracking of the coatings in the zone of the rivets of the doors.

To evaluate the extent of degradation of the surfaces to be protected, observations by scanning electron microscopy (SEM) and elementary analyses by energy dispersion spectroscopy (EDS) were made in samples removed from one of the doors of a driving cabin. An illustrative fraction of the evaluation made on the central part of the front plate of the door, in an area with rivet holes ("disabled") filled in with bitumen is presented (Figure 1).



**Fig. 1 – Samples taken for analysis from the front plate of the driver's cabin door (zone with rivet holes filled in with bitumen).**

The analyses were carried out on a FEG-SEM, model Philips XL-30. Samples were mounted in cross section with cold resin and coated before observation with a gold film (vacuum evaporator JEOL JLC 100).

Figure 2 shows the results of the SEM/EDS analyses made in the right side zone of a filled hole. The analyses allowed to see: i) throughout the sample corrosion zones of the alloy Al 6082, visible punctually on the outer face of the plate and more clearly on the inner face as well as on the side zones of the "disabled" rivet hole; ii) the bitumen layer, formed by more than one hand and with a significant presence of pores, visible in greater quantity in the thicker area, corresponding to the filled zone of the riveting hole; iii) in the same zone, corrosion products were observed at the metallic substrate /bitumen interface.

It was evident from the analyses carried out that: i) unsealed pores make bitumen more permeable to the penetration of corrosive agents and favor the accumulation/stagnation of water which enhances the progression of interstitial corrosion, therefore being necessary to carry out surface preparation [2] [3] with elimination of the corrosion products before application of the painting system, otherwise the phenomenon of corrosion will be enhanced; ii) the evaluation of the state of degradation on both sides of the plate, as well

as carry out adequate maintenance procedures also on both sides of the plate, should be good practices in order to ensure structural integrity; iii) in the tests performed to evaluate the corrosion protection of the paint systems, all the products to be used, in particular bitumen, should be included.

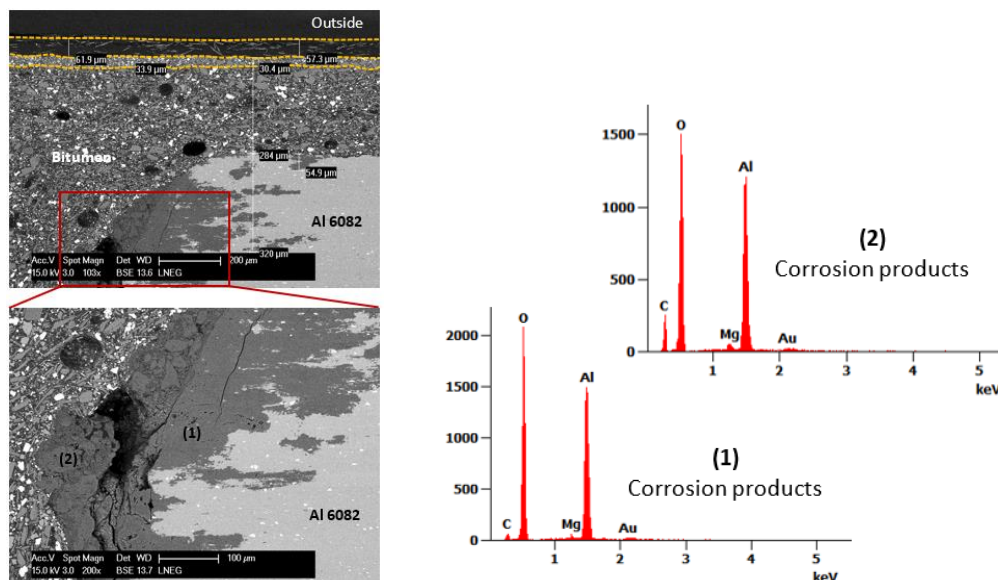


Fig. 2 – Micrograph (BSE/backscattered electrons) and EDS spectra of the sample in cross section, showing corrosion of Al alloy.

### 3. CONCLUSIONS

The study performed showed the importance of carrying out a prior assessment of the extent of corrosion of the substrate and of the degradation of the coatings as the basis for establishing technical procedures so that preventive and maintenance measures are taken in time.

During the maintenance process, it was also proved the importance of a detailed specification covering all the tasks to be performed and of the correct specification of the painting products in relation to the different specificities of rolling stock, as well as the importance of assessing the extent of the existing corrosion and of its types and of monitoring all procedures associated with surface preparation and with the painting process for an adequate corrosion protection of rolling stock.

### REFERENCES

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