

Characterisation of thin films of corrosion products by RF GD-OES – possibilities and challenges

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Knowledge about the elemental and molecular composition of the surface films formed on metals in corrosive environments is essential for the understanding of the corrosion behaviour and corrosion mechanisms of metals and metal coatings. The corrosion products formed are complicated products formed by ion pairing of the ionic forms of the metals with species like, OH⁻, Cl⁻, SO₄²⁻ and H₂O with poor conductivity [1]. Radio Frequency Glow Discharge Optical Emission Spectroscopy (RF GD-OES) is a fast, sensitive technique to obtain the in-depth distribution of elements and thickness of both conducting and insulating surface layers [2]. However, depth profiling of corrosion products presents some challenges:

- Corrosion products on a surface are often both of non-uniform thickness and porous causing difficulties to obtain a vacuum seal against the sample. In several cases, this problem can be overcome by mounting smaller samples in special holders or soft metal pieces, e.g. SnBi alloy.
- several major elements in the corrosion products, e.g. Cl, Na and Ca, are very difficult to quantify due to lack of suitable reference materials.
- Hydrogen is a major element in several of the compounds, strongly affecting several analytical lines of other elements due to the “hydrogen effect”.
- Most likely, the depth profiles are often distorted due to preferential sputtering effects.

In spite of the challenges listed above, RF GD-OES has proven to be a powerful analytical tool for this very difficult analytical problem. The perhaps most demanding challenge is in interpretation of the analytical results obtained. In this work, RF GD-OES results are compared with molecular data from Fourier Transform Infrared (FTIR) spectra [3]. The FTIR results provide identification of the phases present in corrosion products, indirectly providing semi-quantitative elemental composition of the layers investigated. The results show very good agreement with the RF GD-OES data. One particularly interesting result is that the depth profiles show clear signals from Cl at 134,72 nm. It has been suggested that this line is too weak to be useful for analysis, but the data obtained indicate otherwise.

[1]“Atmospheric Corrosion“, C. Leygraf and T. Graedel, John Wiley & Sons, New York, 2000.

[2] R. Payling, D. G. Jones, and A. Bengtson, Glow Discharge Optical Emission Spectrometry. John Wiley & Sons, New York, Weinheim, Brisbane, Singapore, Toronto, 1997.

[3] A. Bengtson and D. Persson, Presented at European Corrosion Congress 2009, 2009, Nice, France.