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CONTINUED CORROSION PROTECTION OF ALUMINIUM ALLOY 2024 THROUGH LAYERED DOUBLE HYDROXIDE UV-DEGRADATIOND. E. L. Vieira ^{1*}; A. N. Salak ¹; J. M. Vieira ¹; C. M. A. Brett ²

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<https://doi.org/10.34637/hnda-e664>

ABSTRACT

In the last decade, the necessity to improve corrosion protection has dramatically affected the industry. Layered double hydroxides emerge as a possibility to overcome this problem due to their ability as a carrier of corrosion protection species. In this work, cerium cations, which possess corrosion protection ability, were incorporated in the LDH structure via partial substitution of aluminium cations. The changes occurring to LDH when exposed for an extended period to UV-radiation and its degradation with release of Ce³⁺ from the hydroxide layers has been studied and is presented in this work.

Keywords: Layered double hydroxides (LDH), Corrosion protection, UV-degradation.

1. INTRODUCTION

Layered double hydroxides (LDH) represent a numerous family of natural 2-D materials. Due to the unique combinations of functionalities, LDH find application in different areas ranging from optoelectronics, catalysis, to corrosion protection. LDH, of general formula $[M^{II}_{1-x}M^{III}_x(OH)_2]^{x+}(A^y)_{x/y} \cdot zH_2O$, are composed of alternating positively charged mixed metal M^{II}-M^{III} hydroxide layers, and interlayers occupied by anions (A^{y-}) and water molecules [1]. The functionalities of LDH can be extended by employing specific cations.

The mechanism of protection by LDH is still not clear. The basic principle consists in the release of anions from the LDH interlayers, followed by the adsorption of organic molecules on the surface of the metallic substrate with a consequent decrease in the corrosion rate [2]. Although the use of anions is the most common method, corrosion protection can also be achieved using cations. Ce³⁺ is well known for its corrosion protection capabilities [3, 4]. Traditionally, it is trapped inside bentonite nano-capsules and is often used with LDH to achieve a synergetic effect and higher corrosion protection efficiency. The efficient inhibition of Ce³⁺ occurs because the reaction between the cerium cations and hydroxide ions leads to the formation of insoluble hydroxide on the cathodic areas.

In this work, the changes occurring to LDH when exposed for an extended period to UV-radiation (30 days) and its degradation with release of Ce³⁺ from the hydroxide layers has been studied. This strategy allows

promoting extended corrosion protection of the metal surface after the end of the anion-exchange process. The study was performed using $Mg_3Al_{1-x}Ce_x$ LDH intercalated with NO_3^- , where x was 7.5 mol%. The UV radiation promotes partial degradation of the hydroxide layer and release of Ce^{3+} leading to a two-step corrosion protection system (Fig. 1). UV-visible spectroscopy was used to quantify the amount of Ce^{3+} released.

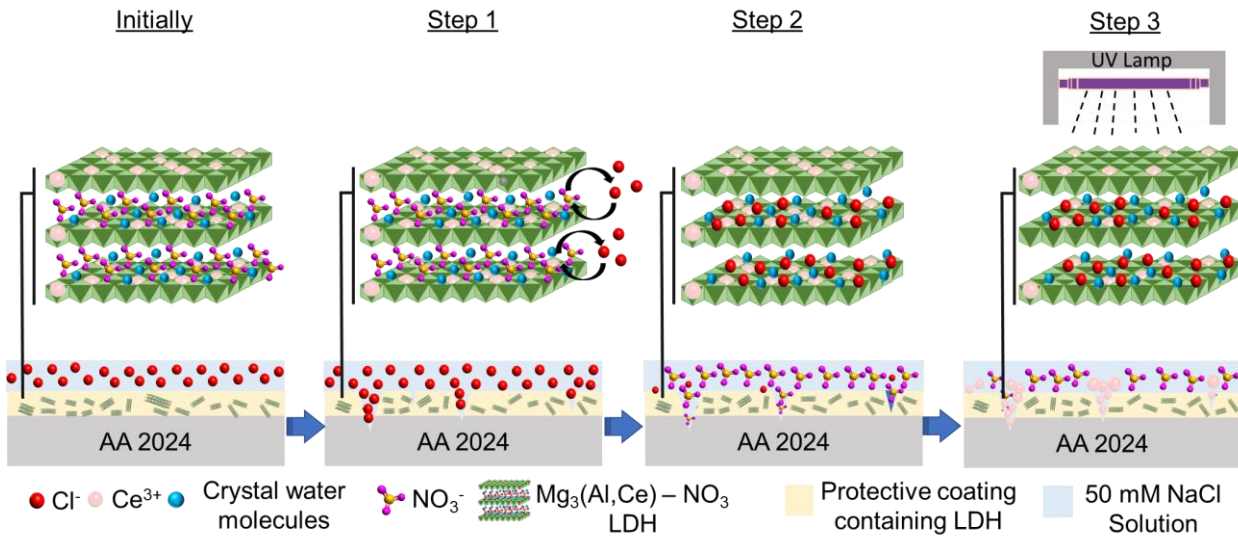


Fig. 1 – Continued corrosion protection of aluminium alloy through LDH UV-degradation [5].

2. DESCRIPTION

The continuous corrosion protection of aluminium alloy 2024 with LDH degradation was assessed using electrochemical impedance spectroscopy (EIS) over a one-week period. Optical microscopy and energy-dispersive X-ray spectroscopy (EDX) were used for surface characterization (Fig. 2).

Impedance spectra were recorded to evaluate the inhibitor efficiency of Ce^{3+} released from the LDH layers, after a previous exposure of the LDH to UV irradiation. Measurements were carried out in AA 2024 using different aqueous solutions.

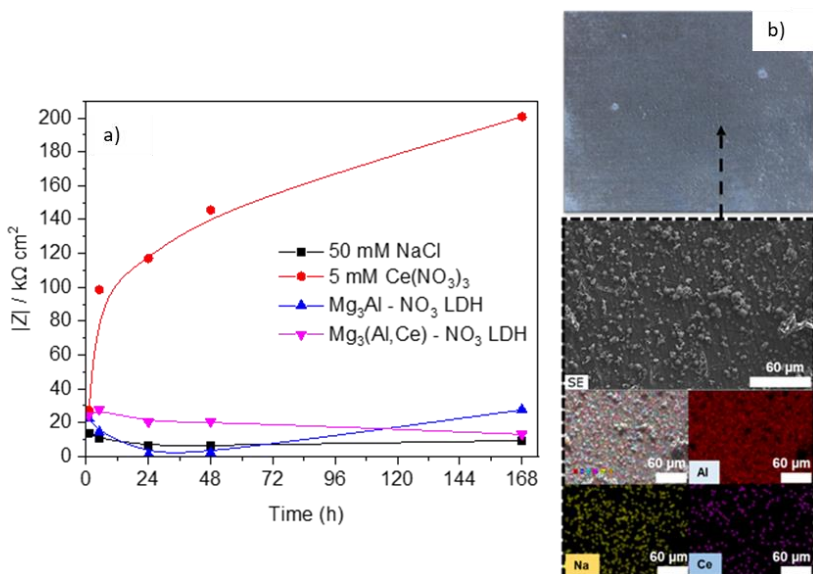


Fig. 2 – a) EIS results for the variation of impedance magnitude $|Z|$ (at 10^{-2} Hz) with time for immersion of AA2024 in 50 mM NaCl solutions in different types of experimental conditions and b) optical microscopy, SEM and EDX analysis for principal elements after AA2024 sample immersion during 1 week 50 mM NaCl + $Mg_3(Al,Ce)-NO_3$ LDH [5].



3. CONCLUSIONS

The amount of Ce^{3+} released after the UV-radiation correspond to 38.4 % of the total amount of Ce^{3+} present in the LDH hydroxide layer structures. Corrosion protection was extended by a 2-step protection system, namely, the Ce^{3+} release through the partial degradation of the LDH nanocontainer and the retaining of corrosion agent Cl^- trapped in the LDH galleries from anion exchange.

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