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Gata Joseph Ayemi, Camille Blivet, Sabrina Marcelin, Sandrine Therias, Leroux Fabrice, Bernard Normand

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## Interesting corrosion protection properties for carbon steel provided by a layered double hydroxides-filled epoxy coating with EDDS intercalation

G.J. Ayemi<sup>1</sup>, C. Blivet<sup>2</sup>, S. Marcelin<sup>1</sup>, S. Thérias<sup>2</sup>, F. Leroux<sup>2</sup>, B. Normand<sup>1</sup>

<sup>1</sup> INSA Lyon, Université Claude Bernard Lyon 1, CNRS, MATEIS, UMR5510, 69621 Villeurbanne, France

<sup>2</sup> Université Clermont-Auvergne-CNRS-UMR 6296, ICCF F-63178 Aubière, France

Organic coatings are widely used to delay contact between an aqueous electrolyte and a metal substrate. These epoxies are often loaded with corrosion inhibitors to act at the water/metal interface and limit metal dissolution. Layered double hydroxides (LDH) are considered as interesting containers for corrosion inhibitors, since they exhibit high ability to release inhibitor as well as to capture aggressive ions from aqueous solution. Epoxy containing organo-modified LDH filler intercalated with ethylenediamine-N,N'-disuccinate anions (EDDS),  $[\text{Zn}_2\text{Al}(\text{OH})_6]^+ [\text{EDDS}]^{4-}_{0.25} \cdot 2\text{H}_2\text{O}$  (LDH-EDDS) with loading from 0% to 1.25% were coated onto carbon steel plates. The efficiency of these coatings against corrosion (barrier properties and release of inhibitors) was assessed by using electrochemical impedance spectroscopy. The evolution of the impedance modulus  $|Z|$  at low frequency range during time showed that the 0.75% organo-modified LDH-containing epoxy (thickness 80  $\mu\text{m}$ ) exhibited the highest corrosion resistance in the series and the associated value of  $|Z|$  at 3 mHz ( $10^{10} \Omega \text{ cm}^2$  after 21 days of immersion in 0.1 mol/L NaCl solution) placed it among the best solutions published so far using organo-modified LDH as cargo carrying a corrosion inhibitor [1].

To understand the corrosion protection mechanism in depth, the neutral sodium chloride solution containing the LDH-EDDS was characterized by ICP-OES. It was shown that  $\text{EDDS}^{4-}$  and  $\text{Zn}^{2+}$  cations are present in solution. This indicates the release not only of the molecule of interest, but also of part of the hydroxide layers constituting the chemical compound scaffold. A synergy effect between  $\text{Zn}^{2+}$  cations and  $\text{EDDS}^{4-}$  anions is highlighted by anodic polarization and electrochemical impedance. In addition, XRD confirms the exchange between  $\text{EDDS}^{4-}$  and chloride anions on the dried powder recovered after the corrosion test and SEM as well as visual observations prove the efficiency provided by the hybrid LDH-EDDS<sup>4-</sup> in protecting carbon steel surface from corrosion.

In summary, the efficiency of the organo-modified filler to inhibit the corrosion process was explained by an exchange between interleaved species occurring from released EDDS<sup>4-</sup> anions and aggressive Cl<sup>-</sup> ions being captured and the synergistic effect between EDDS<sup>4-</sup> and Zn<sup>2+</sup>.

## References

- [1] G.J. Ayemi, C. Blivet, S. Marcelin, S. Thérias, F. Leroux, B. Normand, *Appl. Clay Sci.* 258 (2024) 107510.
- [2] G.J. Ayemi, S. Marcelin, S. Thérias, F. Leroux, B. Normand, *Appl. Clay Sci.* 222 (2022) 106497.