PhD Open Days

Development of smart coatings for corrosion protection of steel

PhD in Chemical Engineering (DEQuim)
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Motivation

The economic impact of **corrosion of metallic** structures is a global industrial issue. Thus, **efficient protection strategies** against metal corrosion are of great importance. **Smart self-healing coating** systems can have a significant contribution to corrosion protection and to sustainability.

Polymeric coatings modified with **micro/nano structured smart additives**, designed and tailored to combat corrosion through their **"autonomous healing ability"**. This is a **revolutionary solution** to increase protection performance and to **extend lifetime** of steel coated materials.

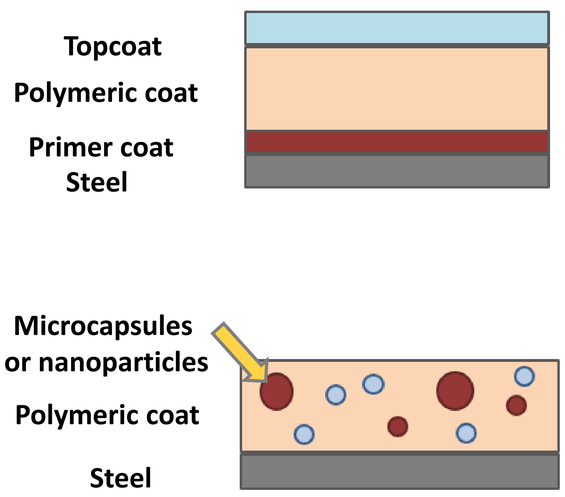
Objective

From

traditional multilayer coatings

to

single layer coating
with **autonomous** and/or
multilevel self-healing ability

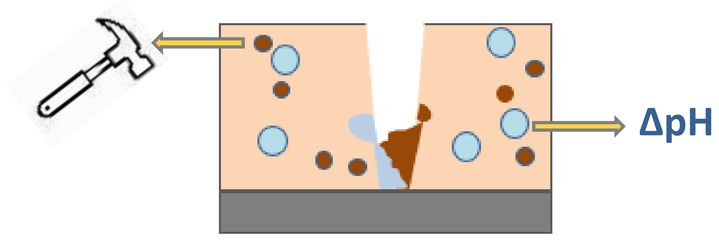


Strategy

addition of **smart-carriers** to the organic coatings

Isophrone diisocyanate Microcapsules (IPDI-MCs)
triger by mechanical force

CeO_2 nanoparticles
pH sensitive



Results and Discussion

1 Polyolefin coating modified with CeO_2 nanoparticles

TEM

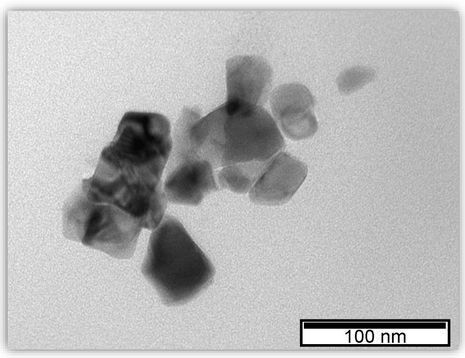
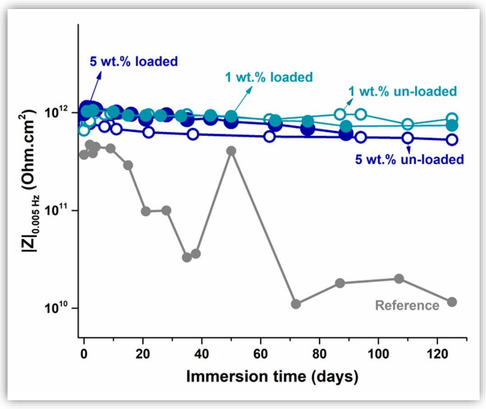


Fig. 1 TEM micrographs of CeO_2 NPs

Elecrochemical Impedance Spectroscopy



Excellent barrier properties

Fig. 2 Comparison of the low frequency impedance values on steel plates coated with reference and modified coatings.

Localized Elecrochemical Impedance Spectroscopy

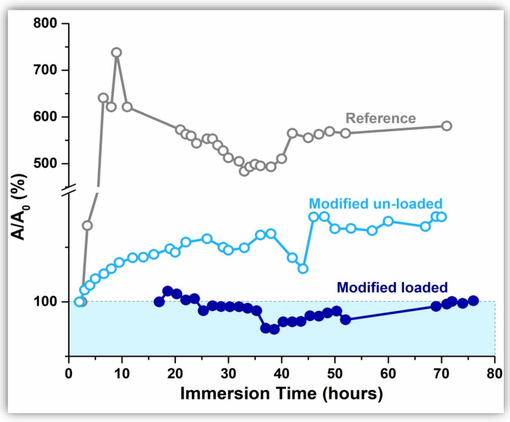


Fig. 3 Evolution of the admittance ratio for the reference and modified coatings during immersion in 0.005 M NaCl solution.

Suppression of corrosion propagation by CeO_2 nanoparticles loaded with corrosion inhibitor

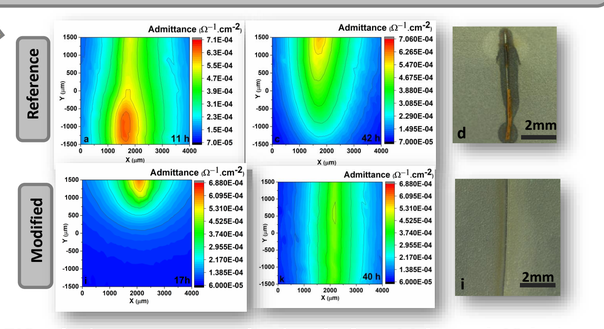


Fig. 4 LEIS admittance maps obtained after 11 h, and 42 h, immersion of the reference coatings (a, c); after 17 h, and 40 h, immersion of modified coating contains NPs loaded with corrosion inhibitor (I, k) respective optical microscope images of each sample at the end of immersion time (d, i)

2 Epoxy coating modified with IPDI-MCs

3 Epoxy coating modified with IPDI-MCs & pH sensitive Cerium organophosphate ($Ce(DEHP)_3$)

Conclusion

1. Smart self-healing polyolefin was developed by addition of CeO_2 nanoparticles loaded withN,N,N',N'-Tetrakis(2-hydroxyethyl) Ethylenediamine.
2. Smart epoxy coating was developed successfully by addition of IPDI-MCs.
3. Smart epoxy with multilevel corrosion protection was developed by simultanouse addition of IPDI-MCs and $Ce(DEHP)_3$.

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