Efficient organic-inorganic hybrid coatings for corrosion protection

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Introduction

Organic-inorganic hybrids are a class of materials formed by two distinct compounds, the organic and inorganic, resulting in a crosslinked phase with characteristics different than the initial elements. The appropriate combinations of both phases results in unique properties of this nanocomposite material. Different forms of hybrids have been intensively studied having their potential applications in sensors, membranes, drug delivery systems and corrosion resistant coatings [1].

In this context the present work aims on the preparation and characterization of hybrid coatings used for efficient corrosion protection of steel surfaces. Special attention is given to the optimization of synthesis conditions (using a factorial analysis) to enhance the methacrylate polymerization leading to improvement of the thermal and electrochemical stability of the material.

Results and discussion

TG/DTG curves showed an efficiency of polymerization of methacrylates higher than 80 % and that the polymeric phase is formed by a large amount of head-tail segments (> 70 %).

The NMR ^{13}C spectra shows the absence of monomer signals indicating the formation of a PMMA/PMPTS phase.

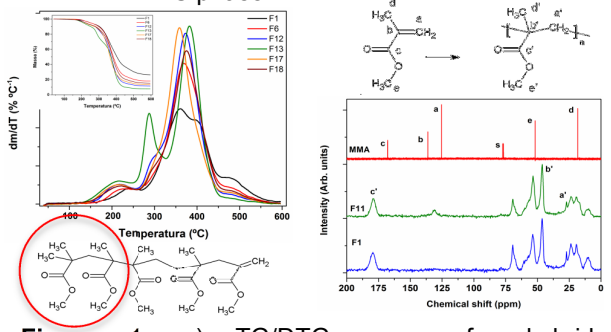

Figure 1: a) TG/DTG curves for hybrids compositions. b) ^{13}C NMR for selected samples.

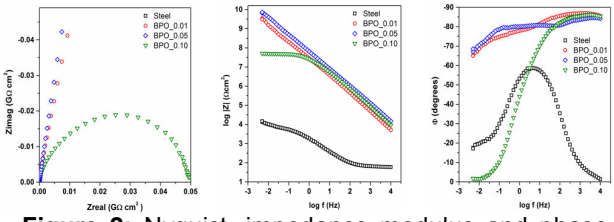

Figure 2: Nyquist, impedance modulus and phase angle plots of the coatings exposed to NaCl 3.5 %.

The hybrids present smooth surface R_{RMS} < 0.5 nm and the coating with ratio BPO/MMA = 0.05 shows the highest corrosion protection performance in contact with standard saline solution (3.5% NaCl).

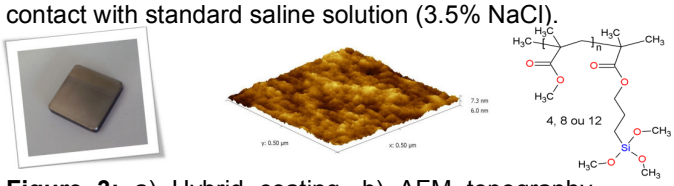

Figure 3: a) Hybrid coating. b) AFM topography c) Chemical environment observed by XPS.

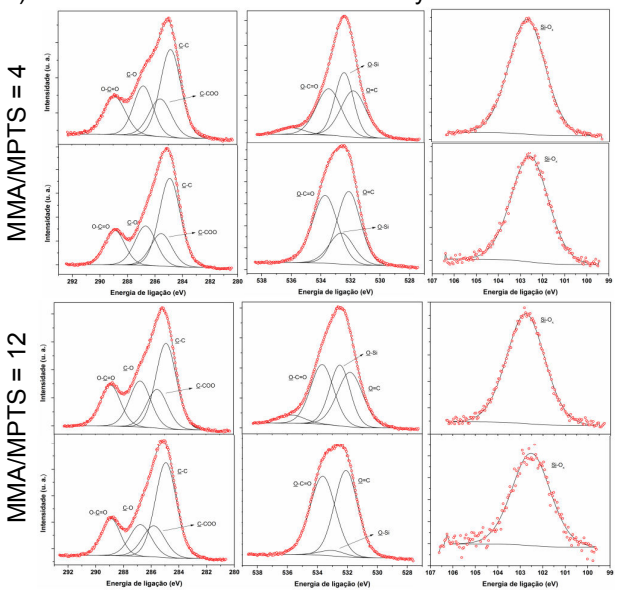

Figure 4: Chemical composition obtained by XPS.

XPS spectra show an increase of C/Si ratio for higher temperatures, reaction time and BPO/MMA ratios, indicative for higher content of the polymeric phase

Conclusions

Optimization of the synthesis conditions of Siloxane-PMMA coatings resulted in a higher polymerization degree, detected by XPS and TG/DTG analysis with 70 % of head to tail segments of the organic phase.

Thin hybrid coatings (2 µm) provide an excellent corrosion protection of carbon steel with impedance up to 10^{10} Ω cm^2 in aggressive medium.

Acknowlegements

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[1]F. C. dos Santos, S. V. Harb, M.-J. Menu, V. Turq, S. H. Pulcinelli, C. V. Santilli and P. Hammer, *RSC Advances*, 2015, **5**, 106754-106763.