

IMPROVEMENT OF ANTICORROSION PROPERTIES OF EPOXY COATINGS ON STEEL WITH NANOCONTAINERS

Ioannis A. Kartsonakis^{*}, Andronikos C. Balaskas, George C. Kordas

Sol-Gel Laboratory, Institute of Materials Science, NCSR "DEMOKRITOS",
153 10 Aghia Paraskevi Attikis, GREECE,
ikartsonakis@ims.demokritos.gr;
abalaskas@ims.demokritos.gr;
gkordas@ims.demokritos.gr

Keywords: Self-healing, EIS, Corrosion, Nanocontainers

ABSTRACT

We present the effectiveness of corrosion protection of epoxy coatings including cerium molybdate nanocontainers for Hot Dip Galvanized Steel. The coatings consist of cross linked polymers with epoxy groups combined with Organic Modified Silicates. The nanocontainers had been previously loaded with corrosion inhibitor 2-mercaptobenzothiazole (2-MB) [1] (Fig. 1). The coatings were deposited via the dip-coating process. The concentration of loaded nanocontainers into the coatings was chosen to be 4 and 10 % w/w. The morphology of the coatings was examined by Scanning Electron Microscopy (SEM). The composition and structure were investigated by Fourier Transform Infrared Spectroscopy (FT-IR) and Energy Dispersive X-Ray Analysis (EDX). Studies on the corrosion resistance of these coatings was made using electrochemical impedance spectroscopy (EIS), open circuit potential (OCP) and potentiodynamic polarization (PP). These studies were carried out using 0.5 M NaCl solution at room temperature.

The results showed that the coatings without nanocontainers or coatings with empty nanocontainers exhibited impedance of 10^7 Ohm cm^2 after 9 days of exposure to corrosive environment 0.5 M NaCl. On the other hand, coatings including 4 % w/w of nanocontainers loaded with 2-MB showed total values of impedance 10^{10} Ohm cm^2 after 9 days of exposure to corrosive environment (Fig. 2). Artificial defects of 2 mm were made to all the coatings in order to study whether our coatings exhibit self-healing properties to be studied via EIS. The artificial defected coatings with 4 w/w concentration of nanocontainers loaded with 2-MB presented total values of impedance 10^9 Ohm cm^2 after one week of exposure to corrosive environment. Moreover, an increase of capacitive behaviour in low frequencies range of Bode plots was observed suggesting possible self-healing effect. PP measurements demonstrated a significant decrease of cathodic currents of coatings including loaded nanocontainers compare to bare substrates.

In conclusion, the incorporation of nanocontainers loaded with 2-MB into the epoxy coatings increases the total impedance value about 2 orders of magnitude compare to coating with empty nanocontainers or without nanocontainers, so one observes a significant improvement of corrosion protection. Furthermore, the artificial defected coatings including nanocontainers presented possible self-healing effect.

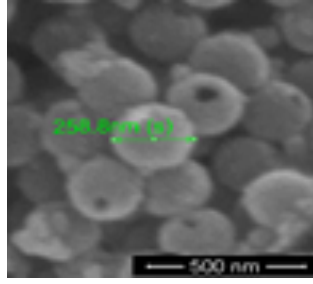


Figure 1: Cerium molybdate nanocontainers.

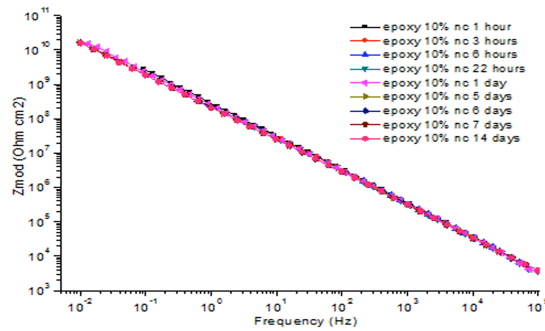


Figure 2: Bode plot of epoxy coating including 10 % w/w of cerium molybdate nanocontainers loaded with 2-mercaptobenzothiazole after exposure to 0.5 M NaCl.

REFERENCES

- [1] I.A. Kartsonakis, G. Kordas, Synthesis and characterization of cerium molybdate nanocontainers and their inhibitor complexes, *J. Am. Ceram. Soc.*, **93**, 2010, pp. 65-73.