Supplementary Materials: Effect of Modified Hexagonal Boron Nitride Nanoparticles on the Emulsion Stability, Viscosity and Electrochemical Behavior of Nanostructured Acrylic Coatings for the Corrosion Protection of AISI 304 Stainless Steel

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1. Polarization Test

1.1. Methodology

The polarization measurements were made in an electrochemical cell using an AUTOLAB PGSTAT204 electrochemical system, immediately after making the EIS measurements, polarizing the working electrode from an initial potential of −100 mV to a final potential of +100 mV as a function of the open circuit potential. The corrosion potential values (E_{corr}) and current density (I_{corr}) were extracted from the polarization curves by the Tafel extrapolation method using the NOVA 2.1 software. The polarization sweep was performed at a scanning speed of 0.001 V/s, with a step of 0.001 V.

1.2. Results and Discussion

Table S1 shows the kinetic parameters of corrosion, i.e., corrosion current density (I_{corr}), corrosion potential (E_{corr}), and corrosion rate for AISI 304 stainless steel, with and without coatings, in the 3.5% by weight solution of NaCl at room temperature. The I_{corr} and E_{corr} were determined from the Tafel extrapolation method using the polarization curves. The current and potential correspond to the point of intersection of the anode and cathodic polarization curves. Besides, I_{corr} represents the rate at which oxidation and reduction reactions equal E_{corr}, so, generally, a higher E_{corr} and a lower I_{corr} indicate better corrosion protection. [1,2] The corrosion rate was obtained from the modified Faraday law equation:

$$\text{Corrosion rate (mm/year)} = \frac{I_{\text{corr}}\left(\text{A}/_{\text{cm}^2}\right) M(\text{g})}{D\left(\text{g}/_{\text{cm}^3}\right)\text{V}} \tag{1}$$

where I_{corr} is the intersection of the anode and cathodic Tafel slopes, M is the molecular weight of steel, D is the density of doing, and V is a constant (3270). These parameters were obtained using the NOVA 2.1 program.

Table S1. Tafel parameters for SS-304, acrylic resin and nanostructured coatings.

Sample	E_{corr} (V)	I_{corr} (A)	Corrosion Rate (mm/year)
SS-304	−0.0963	1.79×10^{-7}	1.42×10^{-4}
Resin	−0.0397	1.81×10^{-9}	1.15×10^{-6}
h-BN0.1	0.0453	1.91×10^{-9}	1.52×10^{-6}
h-BN0.5	−0.0097	8.88×10^{-11}	7.04×10^{-8}
h-BN1	−0.0041	5.65×10^{-12}	4.48×10^{-9}
mh-BN0.1	−0.0300	1.63×10^{-7}	1.29×10^{-4}
mh-BN0.5	0.0281	5.34×10^{-9}	4.24×10^{-6}
mh-BN1	−0.0066	5.31×10^{-11}	4.21×10^{-8}

According to this table, the nanostructured coatings with 0.1% by weight of h-BN without and with surface modification showed an increase in I_{corr} and corrosion rate (1.91×10^{-9} and 1.52×10^{-6}, 1.63×10^{-7} and 1.29×10^{-4}, respectively) compared to pure acrylic resin (1.81×10^{-9} and 1.15×10^{-6}), indicating less resistance to corrosion at low concentrations of h-BN.

However, with the incorporation of 0.5% and 1.0% by weight of unmodified and superficially modified h-BN, they showed a reduction in I_{corr} and corrosion rate of up to two and three orders of magnitude compared to pure acrylic resin. This behavior indicated an increasing significance in its resistance to corrosion compared to acrylic resin and stainless steel 304, which indicates a higher resistance to corrosion. It should be noted that these values of I_{corr} and corrosion rate are much higher than those reported for nanostructured water-based coatings with hexagonal boron nitride nano-sheets but deposited on 316 L stainless steel [3].

References

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