Corrosion Protection of Q235 Steel Using Epoxy Coatings Based on Polyaniline Loaded with Benzotriazole

1. UV-Vis spectra for BTA at different concentrations

The concentration of BTA has a high linear correlation coefficient with the UV-Vis absorbance, so the linear curve of BTA concentration-absorbance was established to calculate to BTA concentration releasing from PANI.

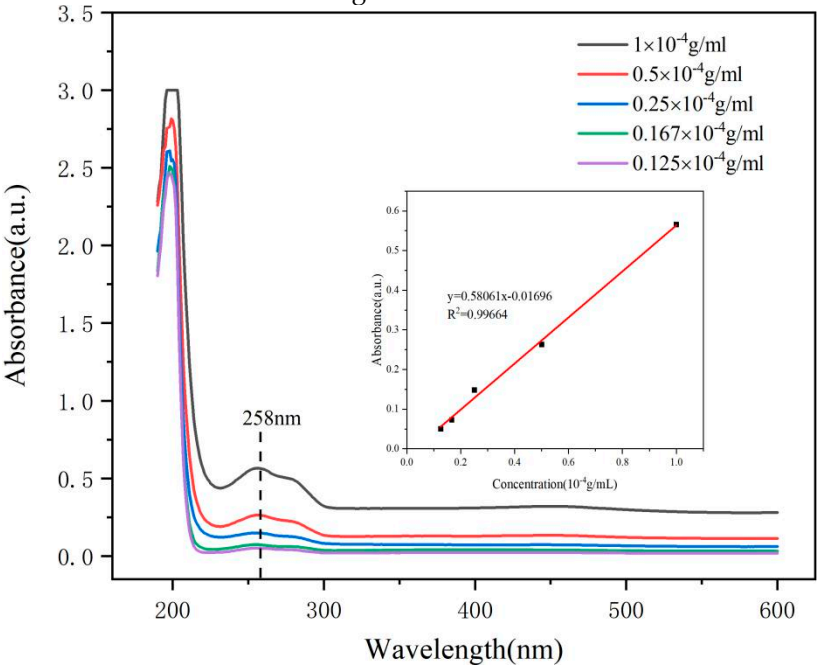


Figure S1. UV-Vis spectra for BTA at different concentrations

First, 0.005g of BTA was dissolved in 50 mL of 3.5wt% NaCl solution to obtain a BTA solution with a concentration of 1×10^{-4} g/mL. Then an appropriate amount of BTA solution with a concentration of 1×10^{-4} g/mL was diluted 2, 4, 6 and 8 times, respectively, to obtain BTA solution with a concentration of 0.5×10^{-4}g/mL, 0.25×10^{-4}g/mL, 0.16710^{-4}g/mL and 0.125×10^{-4}g/mL. The absorbance of each BTA solution with different concentration was tested by UV-Vis spectrophotometer scanning from 190 to 600nm for motoring the peak at 258nm, which was the characteristic absorbance of BTA[17]. The absorbance at 258nm of BTA solutions with the concentration of 1g/ml, 0.5g/ml, 0.25g/ml, 0.167g/ml and 0.125g/ml was 0.5654a.u.,0.26318a.u., 0.14856a.u., 0.07314a.u. and 0.05029a.u., respectively. Linearity of the standard plot of BTA absorbance at varying concentration is depicted in Figure S1 By fitting the concentrations and the absorbance, the standard equation was established (y=0.58061x-0.01696,R^2= 0.99664, where y, x and R^2 were the absorbance of BTA, the concentration of BTA and the correlation coefficient, respectively), which was used to calculate the concentration of BTA in 3.5wt% NaCl solution after monitoring the absorbance at 258nm .
0.015g of HCl-BTA-PANI and PA-BTA-PANI powder were added into 2 cups of 20mL 3.5wt% NaCl solution for magnetic stirring, and the absorbance tests were performed on them when the stirring time was 1h, 3h, 5h and 7h, respectively, and the absorbance value at different stirring time were calculated by the above equation.

2. Hardness and adhesion of the coatings

The hardness and adhesion of varnish coating and coatings with 0.6 wt% PANI materials were tested. The hardness of the coating was tested using the pencil hardness method outlined in the national standard GB/T 6739–2006 "*Paints and varnishes--Determination of film hardness by pencil*

test". The adhesion of the coating was tested using the cross-cut method outlined in the national standard GB/T 9286–1998 "*Paints and varnishes-Cross cut test for films*". The measured data are shown in Table S1.

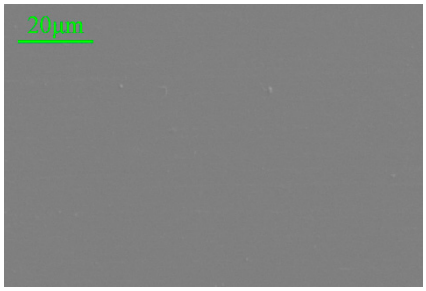
The pencil hardness of different coatings is all rated as 4H, indicating that the type of PANI has little influence on the coating hardness. There are differences in the adhesion of different coatings; the higher the adhesion level, the larger the area from which the coating is peeled off by tape. Testing revealed that, compared to varnish coatings, the adhesion of modified polyaniline coatings is generally improved.

Table S1. Hardness and adhesion of different epoxy coatings

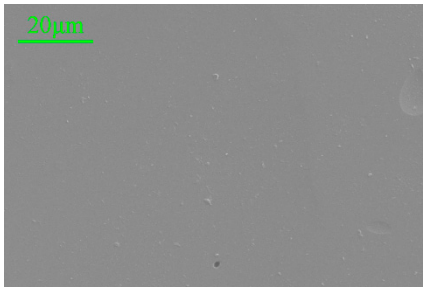
Coating	Hardness	adhesion
EP	4H	1
HCl-PANI/EP	4H	0
PA-PANI/EP	4H	1
HCl-BTA-PANI/EP	4H	0
PA-BTA-PANI/EP	4H	0

3. Defects in the coating surface

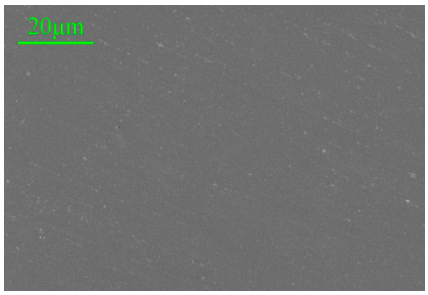
Figure S2 presents the microscopic morphology of HCl-PANI/EP, PA-PANI/EP, HCl-BTA-PANI/EP and PA-BTA-PANI/EP at 1000 times magnification. The images reveal that the PANI powder is uniformly dispersed in the epoxy coatings, without any visible cracks or micropores resulting from powder agglomeration. The surfaces of HCl-PANI/EP and HCl-BTA-PANI/EP are smooth with no obvious folds or microgrooves, indicating that their excellent compatibility with epoxy resin. However, a few micropores are evident on the surface of PA-PANI/EP, and slight folds are observed on the surface of PA-BTA-PANI/EP, likely stemming from diluent volatilization. In summary, all four materials exhibit uniform dispersion in the coating without agglomeration, and the coating displays no apparent cracking or large pores, indicating the excellent compatibility of PANI and BTA with epoxy resin.



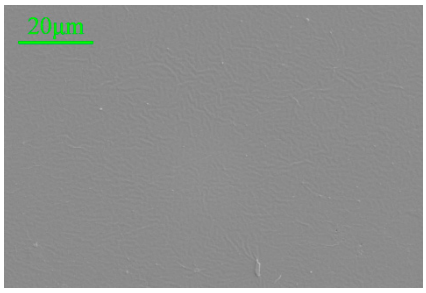
(a) HCl-PANI/EP



(b) PA-PANI/EP



(c) HCl-BTA-PANI/EP



(d) PA-BTA-PANI/EP

Figure S2. SEM for (a) HCl-PANI/EP, (b)PA-PANI/EP, (c)HCl-BTA-PANI/EP and (d)PA-BTA-PANI/EP.