

Supplementary information

Electrochemical Deposition of Zn-HNT/p(EDOT-co-EDOP) Nanocomposite Coating on LN SS for Anti-bacterial and Anti-corrosive Application

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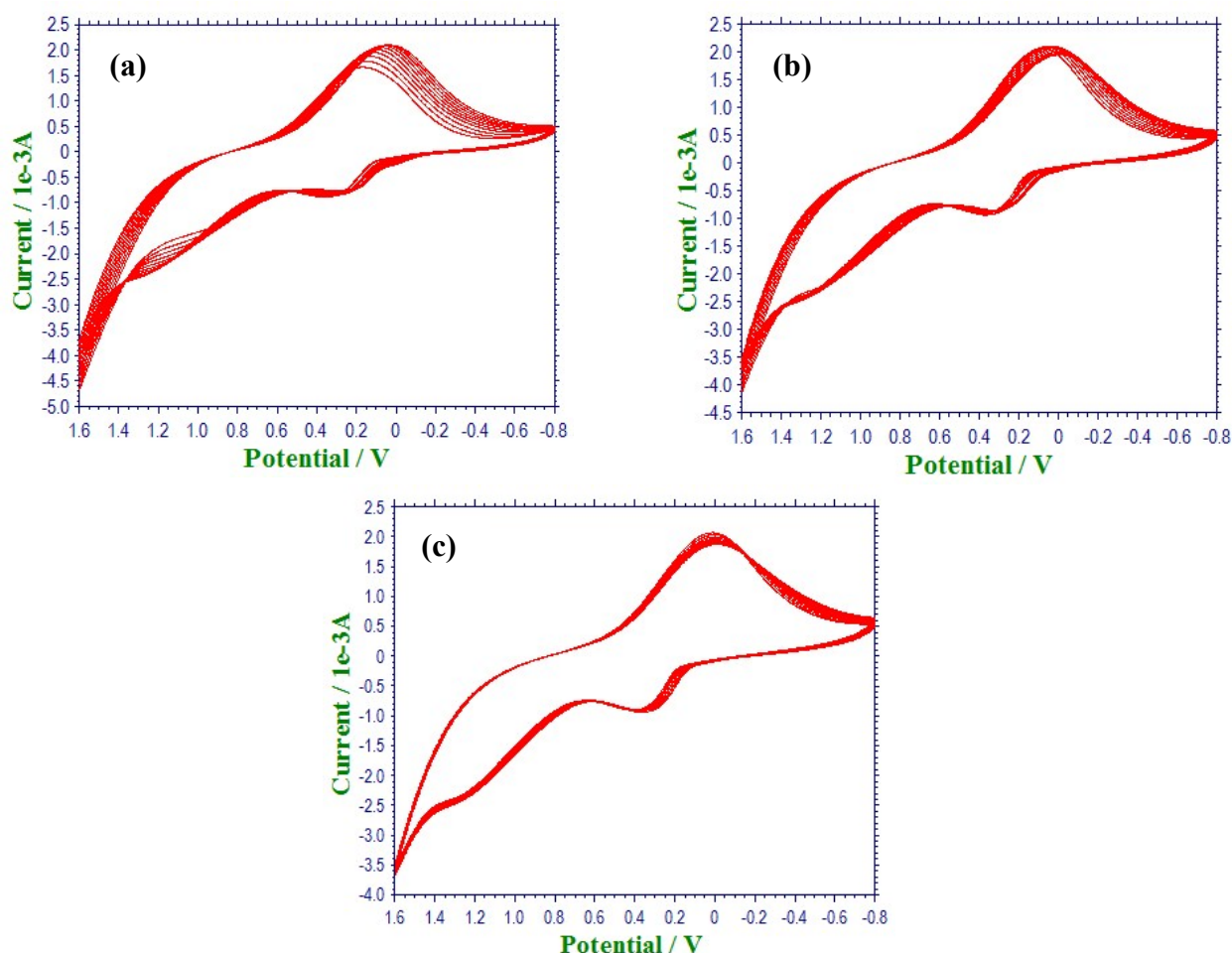


Fig. S1 Cyclic voltammograms of (a) p(EDOT-co-EDOP), (b) Zn/p(EDOT-co-EDOP) and (c) Zn-HNT/p(EDOT-co-EDOP)2% copolymer nanocomposite coating on passivated LN SS for 10 cycle at a scan rate of 100 mV s^{-1} in $\text{LiClO}_4/\text{ACN}$.

As the robustness and stability of the coating are significant in practical applications, the coating worth was evaluated on the basis of the surface uniformity and on the mechanical adhesion of the coating. The electrochemical polymerization of EDOT and EDOP in $0.1 \text{ M ACN/LiClO}_4$ solution was carried out on cycling the potential between -0.8 and $+1.6 \text{ V}$ at a fixed scan rate of 100 mV s^{-1} and for 10 cycles. In order to obtain top quality copolymer coating for anti-corrosion, the optimum monomer feed ratios was (1:1)

copolymer films were obtained on passivated LN SS. As shown in Fig. S1 (a) the monomer oxidation peak was noted as exact anodic peaks beyond + 1.2V vs. SCE compared with Zn/p(EDOT-co-EDOP) and Zn-HNT/p(EDOT-co-EDOP)2% copolymer composites (Fig. S1 b,c). The oxidation and reduction peaks of Zn-HNT/p(EDOT-co-EDOP)2% composite between +0.0 and + 1.5 V vs. SCE appear, indicating the development of homogenous and firm adherent Zn-HNT/p(EDOT-co-EDOP)2% composite coating over the passivated LN SS metal surface. The current values of each oxidation and reduction peaks are greater than that of the p(EDOT-co-EDOP) and Zn/p(EDOT-co-EDOP) cycle which leads to the formation of an electropolymeric Zn-HNT/p(EDOT-co-EDOP)2% material on the passivated LN SS surface.

The XRD pattern indicates that the Zn-HNT coating strongly influenced the amorphous crystalline behavior of the composite coating. For all the XRD spectrum of Zn-HNT/p(EDOT-co-EDOP) nanocomposites shown in Fig. S2 (a-e), the broad diffraction peaks of the 2θ value (22-25) are similar to the p(EDOT-co-EDOP) copolymer coating. A decrease in intensity of broad peak of p(EDOT-co-EDOP) are observed in Zn-HNT/p(EDOT-co-EDOP) after coating on surface of low NSS. The remaining low intense peaks identified in Zn-HNT/p(EDOT-co-EDOP) nanocomposites may be attributed due to amorphous crystalline lattice distortion occurred as a result of Zn-halloysite presence with the copolymer composition as a composite. The amorphous crystalline nature of Zn-HNT is also well-maintained after the coating process under polymerization reaction conditions.

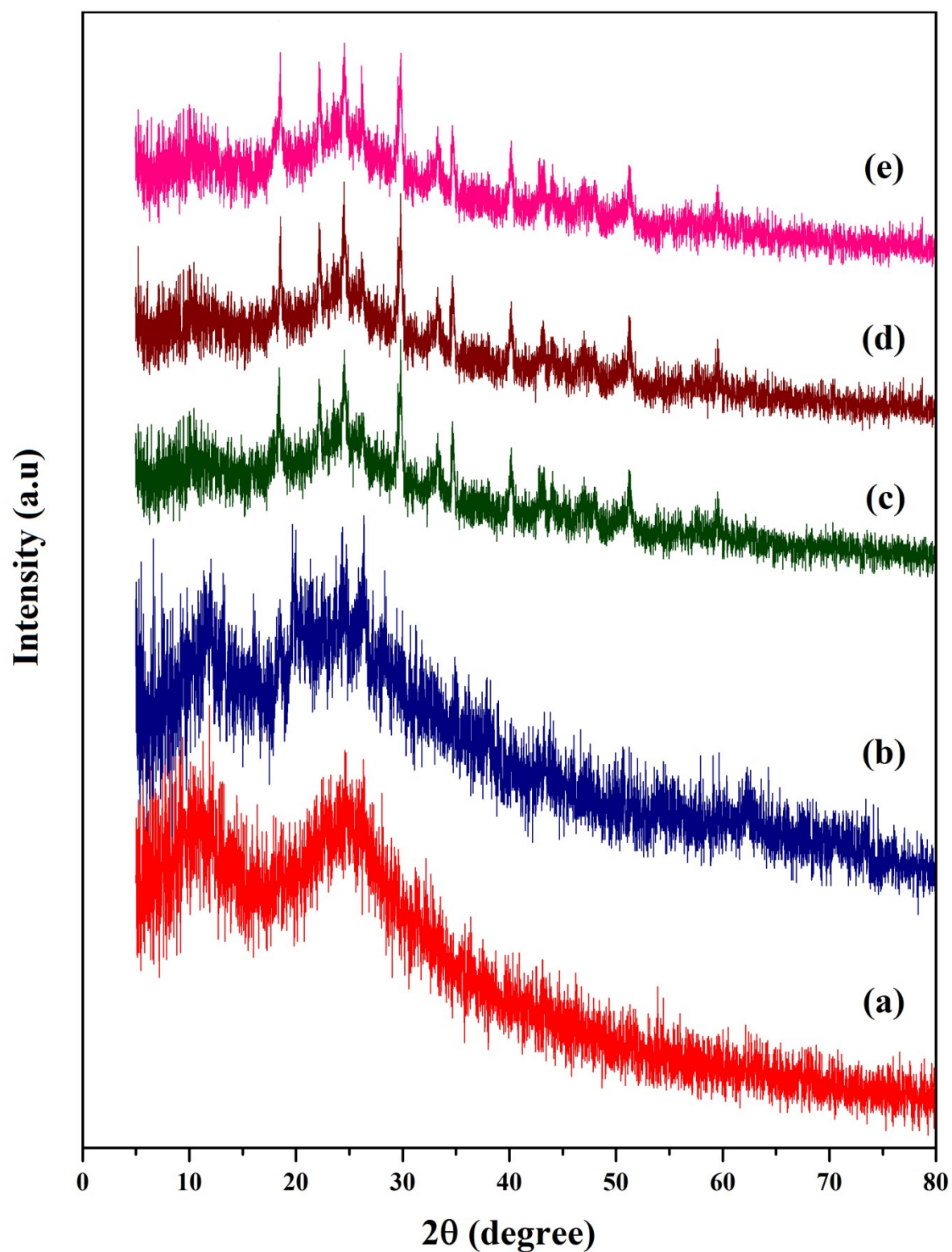


Fig. S2 XRD spectra (a) p(EDOT-co-EDOP), (b) Zn/ p(EDOT-co-EDOP), (c) Zn-HNT/p(EDOT-co-EDOP)1%, (d) Zn-HNT/p(EDOT-co-EDOP)2% and (e) Zn-HNT/p(EDOT-co-EDOP)3% copolymer nanocomposite coating on passivated LN SS.

Fig. S3 (a) shows the adhesion strength of the p(EDOT-co-EDOP), Zn/p(EDOT-co-EDOP) and Zn-HNT/p(EDOT-co-EDOP) 1%, 2% and 3% composite coating on passivated LN SS. The above coated sample is one of the most significant properties for industrial applications. The adhesion strength of the Zn-HNT/p(EDOT-co-EDOP)2% copolymer composite coating on passivated LN SS specimen was measured as 15.1 MPa which was higher than that of the other copolymer and composite coatings on passivated LN SS specimens.

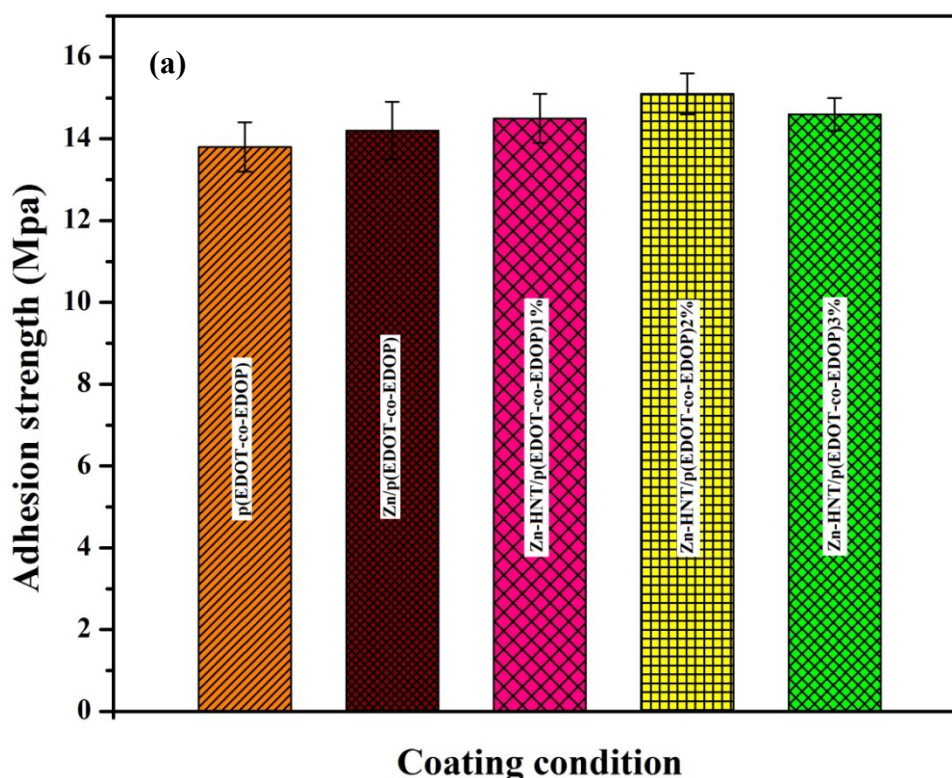


Fig. S3 (a) Adhesion values of p(EDOT-co-EDOP), Zn/ p(EDOT-co-EDOP), Zn-HNT/p(EDOT-co-EDOP)1%, Zn-HNT/p(EDOT-co-EDOP)2% and Zn-HNT/p(EDOT-co-EDOP)3% composite coating on passivated LN SS, respectively.

The Vickers micro-hardness (Hv) of the coating is an important requirement for the industrial application for providing the information about the load bearing tendency with under stress. We have studied, the hardness values of the uncoated LN SS, p(EDOT-co-EDOP), Zn/p(EDOT-co-EDOP) Zn-HNT/p(EDOT-co-EDOP) 1%, 2% and 3% copolymer composite coated LN SS specimen, respectively were evaluated by the Vickers micro hardness test and the values are shown in Fig. S3 (b). The hardness value for Zn-HNT/p(EDOT-co-EDOP) 2% composite coated specimen exhibited higher hardness values 271.9 ± 5.5 . Which is still higher than that of the p(EDOT-co-EDOP) Zn/p(EDOT-co-EDOP) and Zn-HNT/p(EDOT-co-EDOP) 1%, 3% coated specimens.

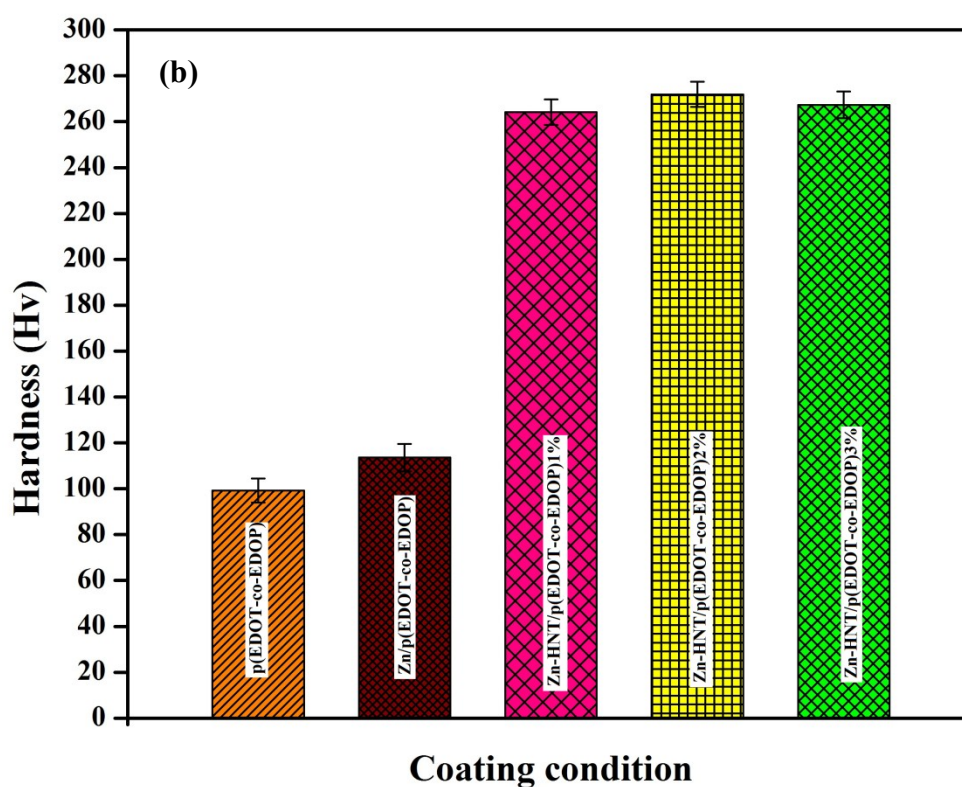


Fig. S3 (b) Hardness values of p(EDOT-co-EDOP), Zn/ p(EDOT-co-EDOP), Zn-HNT/p(EDOT-co-EDOP)1%, Zn-HNT/p(EDOT-co-EDOP)2% and Zn-HNT/pP(EDOT-co-EDOP)3% composite coating on passivated LN SS, respectively.

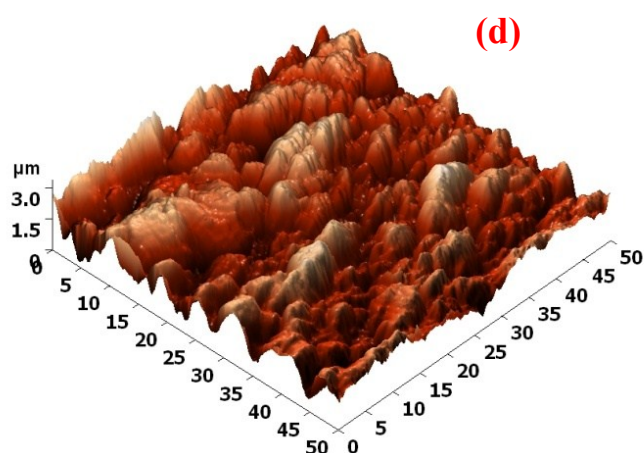
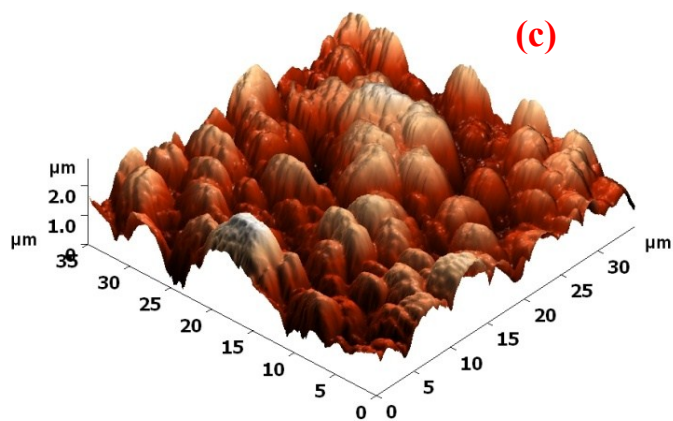
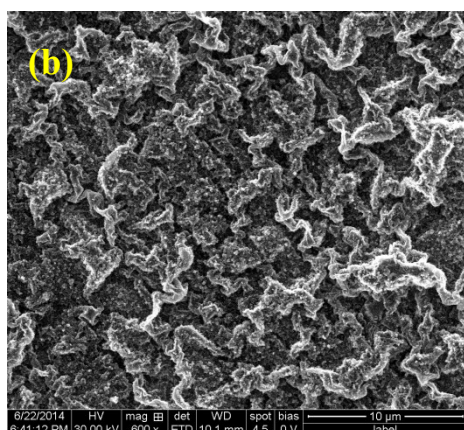
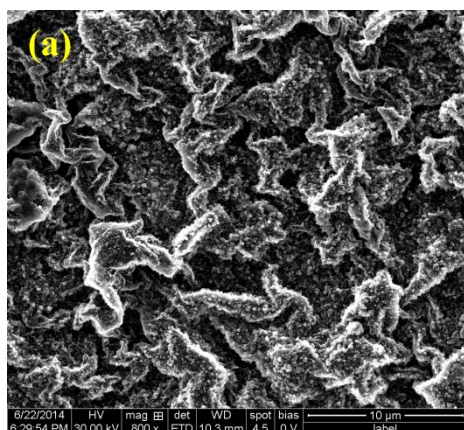


Fig. S4 FESEM images of (a) Zn-HNT/p(EDOT-co-EDOP)1% (b) Zn-HNT/p(EDOT-co-EDOP)3% passivated LN SS, (c-d) AFM image, respectively.

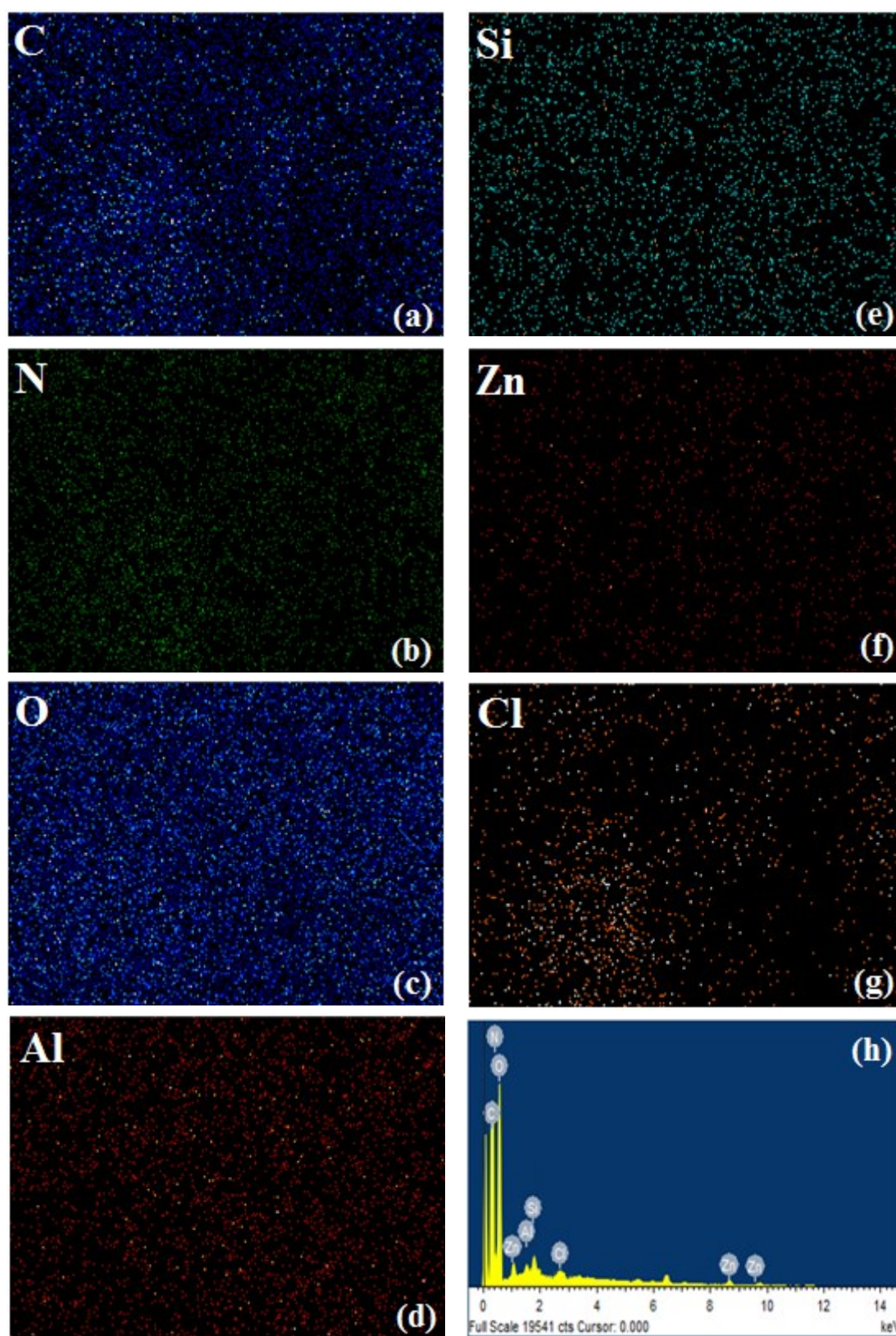


Fig. S5 (a-g) EDX mapping and (h) EDX Spectra of Zn-HNT/p(EDOT-co-EDOP)2% copolymer nanocomposite coating on passivated LN SS.

The as-developed copolymer and composites coating was tested for their antimicrobial effect against the marine bacteria *Pseudoalteromonas sp* and *Desulfatobacter sp* and pathogenic bacteria *S. aureus* and *E. coli* by the well diffusion method. The zone of inhibition against the strains for p(EDOT-co-EDOP), Zn/p(EDOT-co-EDOP) and Zn-HNT/p(EDOT-co-EDOP) coatings of sample is shown in Fig. 6 and Fig. S6. Zn-HNT/p(EDOT-co-EDOP)2% shows the inhibition zone obtained for the Zn-HNT/p(EDOT-co-EDOP)2% coating against the marine bacterias *Pseudoalteromonas sp* and *Desulfatobacter sp*, is higher than for the increase of the inhibition zone for the bacterial strains *S. aureus* and *E. coli*. Thus, it is clear that the Zn-HNT/p (EDOT-co-EDOP)2% coating exhibits excellent antimicrobial activity and this concentration was taken as an optimum condition for the higher antimicrobial activity.

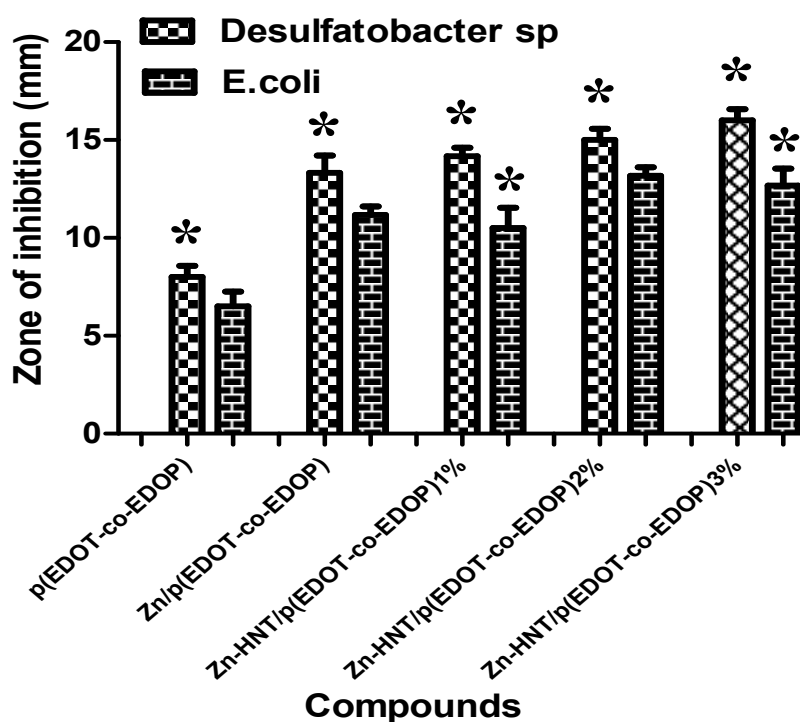


Fig. S6 Anti-bacterial activity of p(EDOT-co-EDOP), Zn/p(EDOT-co-EDOP) and Zn-HNT/p(EDOT-co-EDOP)1%, Zn-HNT/p(EDOT-co-EDOP)2% and Zn-HNT/p(EDOT-co-EDOP)3% composite coating on passivated LN SS.