

Impact of Synthesis Temperature on Anticorrosive Properties of Polyaniline Coatings

Pritee Raotole^{1*}, M. L. Raotole², V.T. Patil¹, V.R. Huse¹, A.Z. Shaikh¹, A. L. Chaudhari¹

MGSM's Arts, Science and Commerce College, Chopda, Maharashtra, India¹

Smt. Sharchchandrika Suresh Patil Institute of Technology, Chopda, Maharashtra, India²

ABSTRACT: The polyaniline coatings were electrochemically synthesized on mild steel at different synthesis temperatures such as 600C, 400C, Room Temperature (RT), 150C, 00C from an aqueous salicylate medium. These coatings were characterized by cyclic voltammetry. The corrosion protection offered by polyaniline coatings to mild steel was investigated in aqueous 3% NaCl solution by potentiodynamic polarization technique. The results of these studies reveal that The polyaniline coatings synthesized at RT shows better corrosion resistant performance as compared to polyaniline coatings synthesized at 600C, 400C, 150C and 00C in 3% NaCl.

KEYWORDS: polymer coatings, Polyaniline, Electrochemical synthesis, Cyclic voltammetry, Mild steel, potentiodynamic polarization.

I. INTRODUCTION

A great deal of research has been devoted to the electrodeposition of conducting polymers on to active metals due principally to their use as anti-corrosion coatings [1]. The electro synthesis of polypyrrole containing molybdate on to aluminium electrodes show that molybdate remains entrapped in to the polymer matrix, providing greater resistance to breakdown of passivity in chloride media [2].

Polypyrrole deposits obtained on copper present excellent corrosion behavior in highly aggressive media such as 3% NaCl. The coatings having low porosity and great homogeneity, due mainly to their constant growth rate. The coatings that are obtained can maintain the passivity of copper for more than 25 days[3]. PANi/Ny coatings can provide an anodic protection against corrosive environments in which the metals are exposed. The corrosion rate for the polymer coated steel was significantly lower than the bare steel (10 to 15 times)[4]. Poly(N-methylaniline) (PNMA) coatings on a steel disc electrode the corrosion rate of these polymer was investigated by anodic potentiodynamic polarization technique and the Tafel test. The corrosion resistance of the PNMA coated steel was found to be considerably higher and the corrosion rate was much slower than that of bare steel [5].

Thermoplastic polymers as a blend of poly(methylmethacrylate) with poly(butylmethacrylate), phenoxy resin and apoly(vinylchloride-co-vinylacetate) 90/10 copolymer and Compared with an alkyd resin containing 0.2, 0.4 and 0.6% (w/w) of polyaniline, three different thermoplastic systems (vinyl copolymer, a blend of two acrylic polymers, and the phenoxy resin) were selected in order to evaluate the corrosion resistance and compare the results with an alkyd resin modified with polyaniline as a conductive polymer. The presence of conductive polymer in alkyd resin improve the protection against corrosion of the metal and the degradation resistance of the coating, improving the overall performance of the coated steel [6].

II. ELECTROCHEMICAL SYNTHESIS

The coatings were synthesized using cyclic voltammetry. The electrochemical synthesis was carried in a single-compartment, three-electrode cell with mild steel as a working electrode, platinum as a counter electrode, and saturated calomel electrode (SCE) as a reference electrode. The cyclic voltammetric conditions were maintained using

a PARSTAT 2363-1, EG and G, Higher temperature i.e. 60°C and 40°C was maintained by heater. While the lower temperature 15°C was maintained by using ice surrounding the bath. The 0°C temperature was set by using the mixture of salt and ice surrounding the bath.

III. RESULT AND DISCUSSIONS

A. POLYANILINE COATINGS SYNTHESIZED AT DIFFERENT SYNTHESIS TEMPERATURE

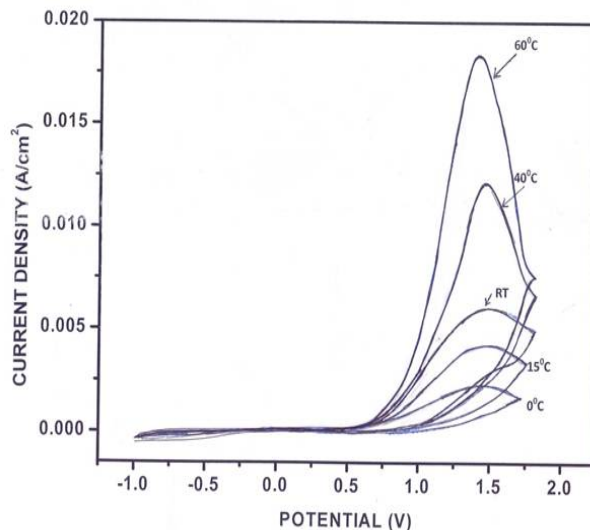


Fig 1: First scan of cyclic voltammograms recorded during the ECP of polyaniline at different synthesis temperatures such as 60°C, 40°C, Room Temperature (RT), 15°C, 0°C

Figure 1 shows the cyclic voltammograms recorded during the ECP of polyaniline at different synthesis temperatures such as 60°C, 40°C, Room Temperature (RT), 15°C, 0°C. These cyclic voltammograms show similar characteristics such as they are characterized by oxidation peak B and small reduction peak C. The oxidation peak B is attributed to the oxidation of aniline, while peak C corresponds to the reduction of deposited polyaniline films at different synthesis temperatures.

However, the careful examination of these cyclic voltammograms shows systematic variations in current densities corresponding to peak B. At higher temperatures such as 60°C and 40°C, it has current densities of 0.01842 A/cm² and ~0.01125 A/cm², respectively. At temperatures such as R.T., 15°C, and 0°C, it has current densities of 0.00785, 0.0025 A/cm², and ~0.0015 A/cm², respectively.

Thus, current densities corresponding to peak B show the sequence: 60°C (0.01842 A/cm²) > 40°C (0.01125 A/cm²) > R.T. (0.00785) > 15°C (0.0025 A/cm²) > 0°C (0.0015 A/cm²)

At higher temperatures such as 60°C, 40°C, it shows higher current densities for peak B, which results in over-oxidation of the monomer, revealing its degradation. The film shows a thick, dull black coating with pores on it. However, at RT, the current density of peak B is intermediate, showing a uniform, pore-less coating. But at lower temperatures such as 15°C, 0°C, the current densities of aniline do not give the expected oxidation/reduction behavior, so the peaks are depressed, resulting in very thin, slightly shiny coatings.

On subsequent scans, the current density corresponding to peaks B and reduction peak C gradually goes on decreasing with the number of scans.

B. EVALUATION OF CORROSION RESISTANT PROPERTIES OF POLYMER SYNTHESIZED AT DIFFERENT SYNTHESIS TEMPERATURE

The corrosion potential (E_{corr}) of polyaniline synthesized at **higher temperature** means 60°C and 40°C was **negatively shifted by 106 mV and 32 mV resp.** also the corrosion rate increased by 52 and 15 times resp. than that of polyaniline coatings synthesized at room temperature.

However at **lower temperature** means 15°C and 0°C there is slight difference in corrosion potential but the **corrosion rate ~ 10 times increased** than that of polyaniline coatings synthesized at RT this may result due to formation of thin coatings at lower temperature.

Table 1
Results of the potentiodynamic polarization measurements

Synthesis temperature	E_{corr} (mV)	I_{corr} (A/cm ²)	Corrosion Rate (mmpy)
60°C	-464	2.60x10 ⁻⁶	0.0308
40°C	-390	7.62x10 ⁻⁸	0.00083
RT	-358	5x10 ⁻⁸	0.00058
15°C	-361	3.56x10 ⁻⁷	0.00413
0°C	-336	2.08x10 ⁻⁷	0.00237

Results reveals that decay in anticorrosive properties of polyaniline coatings occurs when synthesized at higher temperatures due to over oxidation of monomer.

However at lower temperature aniline does not give expected oxidation, reduction behavior so the peaks are depressed and shows low current densities of peaks. So very low amount of polymer was deposited with lower growth rate resulting in thin film.

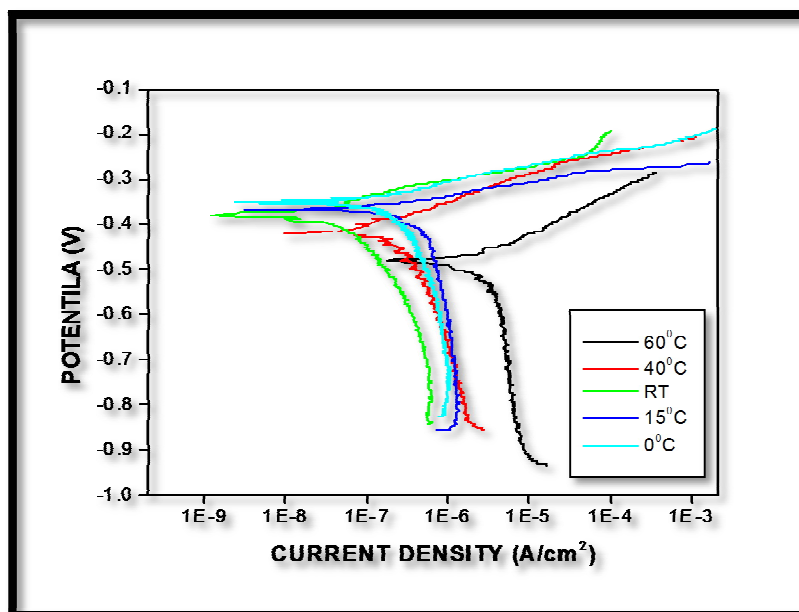


Fig2 :Potentiodynamic polarization curves of polyaniline coatings deposited at different synthesis temperature in 3% NaCl

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization

Volume 6, Special Issue 1, January 2017

International Conference on Recent Trends in Engineering and Science (ICRTES 2017)

20th-21st January 2017

Organized by

Research Development Cell, Government College of Engineering, Jalagon (M. S), India

IV. CONCLUSIONS

- i) The polyaniline coatings were successfully synthesized from an aqueous sodium salicylate solution by cyclic voltammetry at different synthesis temperatures such as- 60^oC, 40^oC, Room Temperature (RT), 15^oC, 0^oC.
- ii) The anticorrosive properties of resulting coating was investigated by the potentiodynamic polarization technique in 3% NaCl at room temperature.
- iii) The potentiodynamic polarization measurements reveal that the Polyaniline coatings synthesized at RT effectively protect mild steel and have higher anticorrosive behaviour against corrosion of mild steel in 3% NaCl.

ACKNOWLEDGEMENT

Author would like to acknowledge UGC for the financial support via minor research project. The first author would also like to acknowledge Prof. P. P. Patil from North Maharashtra University specially for providing the lab for synthesis and testing the corrosion performance of samples as well as for the co-operative environment during this work & North Maharashtra University for funding through VCRMS project.

REFERENCES

- [1] G.Inzelt,M.Piner,J.W.Schultze,M.A.Vorotyntsev,Electrochim.Acta45(2000)2403.
- [2]I.L.Lehr,S.B.Saidman ElectrochimicaActa51(2006)3249–3255
- [3] P.Herrasti , A. I. del Rio, J. Recio ElectrochimicaActa52(2007)6496–6501
- [4] R.Ansari,AmirH.AlikhaniJ.Coat.Technol.Res., 6 (2)221-227,2009
- [5] Aziz Yagan, NuranOzcicekPekmez, Attila Yildiz Journal of Electroanalytical Chemistry 578 (2005) 231-238
- [6] Jose IgnacioIribarrenLaco , Francisco Cadena Villota ,Francisco LiesaMestres Progress in Organic Coatings 52 (2005) 151–160