Advances in Engineering Science
Sect. A (1), Sept. - Dec. 2007, PP 33-36

ELECTROCONDUCTING POLYMERS AS A CORROSION PROTECTION MATERIALS REVIEW

A. Kupniewska* and S. Biallozor

Gdansk University of Technology, ul. Narutowicza 11/12, 80-952 Gdansk, Poland

INTRODUCTION

Electroconductive polymers (ECP) have been extensively studied during last years. First experiments were carried on noble material supports (like gold, platinum or glassy carbon) but more practical attempts concern ECP deposited onto active metals support. It was found that the ECP can be deposited onto the most of active metals like iron, aluminium, zinc, copper, nickel and their alloys. Polymers can be deposited in both ways: chemically or electrochemicaly, from organic solvents or water solutions [1] inspite of the simultaneous processes of anodic metal dissolution. However, the dissolution or passivation of active metal as a result of electrosynthesis of polymer film during anodic polarisation is not the only problem connected with using active supports. The further difficulties concern stability of polymer modified support in corrosive conditions of electrolytes used in devices. Among numerous possible applications of the ECPs films in practics the possibility of they application in corrosion protection of metals recently have been studied intensivly. Below the papers devoted to this problem which have been publicated in 2006-2007 years are reviewed.

Most of publications concern with electrosynthesis of the ECPs layer as a protective films for iron [2-8] and mild steel, carbon steel or stainless-steel [9-54], but non-ferrous metals as a support for electrodeposition of ECPs layer have been also used : aluminium and its alloys [55-63], copper [64- 73], nickel [74-76], zinc [77,22] and magnesium alloys [78,79].

Among the polymers more often were examined: polypyrrole (PPy) [2, 3, 5, 7, 17, 19-22, 33, 34, 41; 42; 47; 54-59; 68, 70-72, 75, 77] or its composite e.g. [27] and polyaniline (PANI) [4,9-11, 28, 35, 36, 40, 43, 48, 51; 54; 56; 61; 62; 63, 65, 73, 74], or its composite film like: PANI + TiO_2 [12,14] or PANI with acrilic and epoxy [18] and bilayer PPy/PANI was also recomended as a protective coating [31]. Conducting pyrrole derivatives film for nickel protection against corrosion was studied [76]. Among other polymers poly(N-ethylaniline) (PNEA) [8,16,25,26] and poly(o-anisidine) [13, 66] also attract investigators attention.

Application of the copolymer film has been suggested, eg. N-methylpyrrole; 3,4-ethylenedioxythiophene [37,38]. Also heterogeneous blends of a soluble substituted polyaniline, poly (2,5-dimethoxy aniline) (PDMA), and two fluoropolymers, poly(vinylidene fluoride) and poly(tetrafluoroethylene-co-vinylidene fluoride-co-propylene) have been prepared and examined on steel [39]. Using sulfonated polypyrrole [44] and hybride materials [24] as well as electrochemically synthesized polypyrrole coating modified with very thin graphite layer and top coated with another polypyrrole film [47] as a protective coating for steel were proposed. Poly(2,5-dimethylaniline) coatings and poly(o- toluidine) (POT) coatings were synthesized and examined on copper [65,67].

Conductive polymers may be used too as pigments in anticorrosive coatings [80-87].

CONCLUSION

The electroconducting polymers are interesting materials for corrosion protection and a number of publication concerning them still growing.

*akupniewska@orange.pl

REFERENCES

1. S.Biallozor, A.Kupniewska, Synth. Met. 155, 2005, P 443 (review).
2. T.Van Schaftinghen. C.Deslouis, A.Hubin and H.Terryn, Electrochim. Acta 51, 2006, P 1695.
3. M.Bazzaoui, S.C.Costa, E.A.Bazzaoui, T.C.Reisa and L.Martins, Electrochim. Acta 51, 2006, P 4516.
4. C.Jeyaprabha, S.Sathiyanarayanan and G.Venkatachari, Appl. Surf. Sci. 253, 2006, P 432.
5. R.Aitout, L.Makhloufi and B.Saidani, Thin Solid Films 515, 2006, P 1992.
6. S.Souza, Surf. Coat. Technol. 201, 2007, P 7574.
7. I.L.Lehra and S.B.Saidman, Corr. Sci.49, 2007, P 2210.
8. A.Yağana, N.Ö.Pekmez and A.Yildiza, Surf. Coat. Technol. 201, 2007, P 7339.
9. C.Ocampo, R.Oliver, E.Armelin, C.Alemán and F.Estrany, J. Polymer Research 13, 2006, P 193.
10. S.Sathiyanarayanan, S.Muthukrishnan and G.Venkatachari, Electrochim. Acta 51, 2006, P 6313.
11. S.Sathiyanarayanan, S.Syed Azim and G.Venkatachari, Synth. Met. 157, 2007, P 205.
12. S.Sathiyanarayanan, S.Syed Azim and G. Venkatachari, Electrochim. Acta 52, 2007, P 2068.
13. M.G.Wankhede, A.B. Gaikwad and P.P. Patil, Surf. Coat. Technol. 200, 2006, P 2240.
14. T.Tüken, B.Yazıcıa and M.Erbila, Materials Chem. Phys. 99, 2006, P 459.
15. T.Tüken, B.Yazıcı and M.Erbil, Appl. Surf. Sci. 252, 2006, P 2311.
16. A.Yağan, N.Ö.Pekmez and A.Yıldız, Electrochim. Acta 51, 2006, P 2949.
17. G.Tansuğ, T.Tükena, A.T.Özyılmaza, M.Erbila and B.Yazıcıa, Curr. Appl. Phys. 7, 2007, P 440.
18. B.N.Grgur, M.M.Gvozdenović, V.B. Mišković-Stanković and Z.Kačarević-Popović, Progr. Org. Coat. 56, 2006, P 214.
19. B.N.Grgur, P.Živković and M.M. Gvozdenović, Progr. Org. Coat. 56, 2006, P 240.
20. U.Riaz, S.M.Ashraf and S.Ahmad, Progr. Org. Coat. 59, 2006, P 138.
21. T.Ohtsuka,M.Iida and M.Ueda, J. Solid State Electrochem.10, 2006, P 714.
22. G.Paliwoda-Porebska, M.Rohwerder, M.Stratmann, U.Rammelt, L.M.Duc and W.Plieth, J. Solid State Electrochem. 10, 2006, P 730.
23. S.U.Rahmana, M.A.Abul-Hamayela and B.J.Abdul Aleemb, Surf. Coat. Tech. 200, 2006, P 2948.
24. J.Bonastrea, P.Garcésb, F.Huertaa, C.Quijadaa, L.G.Andiónb and F.Casesa, Corr. Sci. 48, 2006, P 1122.
25. A.Yağana, N.Ö.Pekmez and A.Yıldıza, Synth. Met. 156, 2006, P 664.
26. A.Yağana, N.Ö.Pekmez and A.Yıldıza, Progr. in Org. Coatings 57, 2006, P 314.
27. D.M.Lenza, M.Delamarb and C.A.Ferreira, Progr. in Org. Coatings 58, 2007, P 64.
28. K.Saravanan, S.Sathiyanarayanan, S.Muralidharan, S.Syed Azim and G.Venkatachari, Progr. in Org. Coatings 59, 2007, P 160.
29. D.Kowalski, M.Ueda and T.Ohtsuka, Corr. Sci. 49, 2007, P 344.
30. A.T. Özyılmaz, G. Ozyilmaza and N. Çolaka, Surf. Coat. Technol. 200, 2006, P 2484.
31. A.Yağan, N.Ö.Pekmez and A.Yıldız, Progr.Org. Coatings 59, 2007, P 297.
32. Y.Chena, X.H.Wang, J.Lia, J.L.Lua and F.S.Wang, Electrochim. Acta 52, 2007, P 5392.
33. T.Tüken, B.Yazıca and M.Erbila, Materials & Design 28, 2007, P 208.

34. T. Zhang and C.L. Zeng, Electrochimica Acta 50, 2005, P 4721.

35. S.Sathiyanarayanan, S. Devi and G. Venkatachari, Prog. in Org. Coatings 56, 2006, P 114.

36. T.C. Girija and M.V. Sangaranarayanan, Synth. Met. 156, 2006, P 244.

37. R.Oliver, A.Muńoz, C.Ocampo, C.Alemán, E.Armelin and F.Estrany, Chem. Phys.328, 2006, P 299.

38. M.A.Lucio García and M.A.Smit, J. Power Sources 158, 2006, P 397.

39. G.A.Moraga, G.G.Silva, T.Matencio and R.M.Paniago, Synth. Met. 156, 2006, P 1036.

40. A.T.Ozyılmaz, M.Erbil and B.Yazıcı, Thin Solid Films 496, 2006, P 431.

41. T.Tüken, Surf. and Coat. Technology 200, 2006, P 4719.

42. T.Tüken, Surf. Coat. Technol. 200, 2006, P 2782.

43. L.Zhong, H.Zhu, J.Hu, S.Xiao and F.Gan, Electrochim. Acta 51, 2006, P 5494.

44. E.Hür,G.Bereket and Y. ahin, Materials Chem. and Phys. 100, 2006, P 19.

45. E.Hür, G.Bereket and Y. ahin, Progr. in Org. Coat. 57, 2006, P 149.

46. M.Düdükcü and F.Köleli, Progress in Org. Coatings 55, 2006, P 324.

47. T.Tüken, G.Tansuğa, B.Yazıcıa and M.Erbila, Progr.Org. Coatings 59, 2007, P 88.

48. E.Hür, G.Bereket and Y. ahin, Curr. Appl. Phys. 7, 2007, P 597.

49. D.Sazou and D.Kosseoglou, Electrochim. Acta 51, 2006, P 2503.

50. D.Sazou, M.Kourouzidou and E.Pavlidou, Electrochim. Acta 52, 2006, P 4385.

51. L.Zhong, S.Xiao, J.Hu, H.Zhu and F.Gan, Corr. Sci.48, 2006, P 3960.

52. M.Kralji Roković, K.Kvastek, V.Horvat-Radošević and Lj.Duić, Corrosion Sci. 49, 2007, P 2567.

53. S.Chaudhari, S.R. Sainkar and P.P. Patil, Progr. in Org. Coatings 58, 2007, P 54.

54. J.G.Gonzalez-Rodriguez, M.A.Lucio-García, M.E.Nicho, R.Cruz-Silva, M.Casales and E.Valenzuela, J. Power Sources 168, 2007, P 184.

55. M.Bazzaoui, J.I.Martins, S.C.Costa, E.A.Bazzaoui, T.C.Reis and L.Martins, Electrochim. Acta 51, 2006, P 2417.

56. T.Wanga and Y.J. Tan, Corr. Sci.48, 2006, P 2274.

57. J.I. Martins, S.C. Costa, M. Bazzaoui, G. Gonçalves, E. Fortunato and R. Martins, J. Power Sources 160, 2006, P 1471.

58. J.I. Martins, S.C. Costa, M.Bazzaoui, G.Gonçalves, E.Fortunato and R.Martins, Electrochim. Acta 51, 2006, P 5802.

59. I.L. Lehr and S.B. Saidman, Electrochimi. Acta 51, 2006, P 3249.

60. I.L. Lehr and S.B. Saidman, Materials Chem. and Phys. 100, 2006, P 262.

61. T. Wang and Y.J. Tan, Materials Sci. and Eng.: B 132, 2006, P 48.

62. T. Wang and Y.J. Tan, Corrosion Sci. 48, 2006, P 2274.

63. L.Cecchetto, R.Ambat, A.J.Davenport, D.Delabouglise, J.-P.Petita and O.Neelc, Corrosion Sci. 49, 2007, P 818.

64. V.Shinde, A.B.Gaikwad and P.P. Patil, Appl. Surf. Sci. 253, 2006, P 1037.

65. V.Shinde, A.B.Mandale, K.R.Patil, A.B.Gaikwad and P.P. Patil, Surf. Coat. Technol. 200, 2006, P 5094.

66. S.Chaudhari, A.B.Mandale, K.R.Patil, S.R. Sainkar and P.P. Patil, Surf. Coat. Technol. 200, 2006, P 5557.

67. T. Tüken, B. Yazıcı and M. Erbil, Surf. Coat. Technol. 200, 2006, P 4802.

68. L.M.Martins dos Santos, J.C.Lacroix, K.I.Chane-Ching, A.Adenier, L.M.Abrantes and P.C.Lacaze, J.Electroan.Chem. 587, 2006, P 67.

69. P.Pawara, A.B.Gaikwadb and P.P.Patil, Electrochim. Acta 52, 2007, P 5958.

70. P.Herrasti, A.I.del Rioa and J.Recioa, Electrochim. Acta 52, 2007, P 6496.

71. M.I.Redondo and C.B.Breslin, Corr. Sci.49, 2007, P 1765.

72. J.Wang, Y.Xu, X.Sun, Sh.Mao, and F.Xiao, J. Electrochem. Soc. 154, 2007, P C445.

73. A.T.Özyılmaz, Surf. Coat. Technol. 200, 2006, P 3918.

74. T.C.Girij and M.V.Sangaranarayanan, J. Power Sources 156, 2006, P 705.

75. Y.Haseko, N.K.Shrestha, S.Teruyama and T.Saji, Electrochim. Acta 51, 2006, P 3652.

76. F. Lallemand, D. Auguste, C. Amato, L. Hevesi, J. Delhalle and Z. Mekhalif, Electrochim. Acta 52, 2007, P 4334.

77. J.Vatsalarani, S.Geetha, D.C.Trivedi and P.C.Warrier, J. Power Sources 158, 2006, P 1484.

78. S.Sathiyanarayanan, S.S.Azim and G. Venkatachari, Appl. Surf. Sci. 253, 2006, P 2113.

79. S.Sathiyanarayanan, S.S.Azim and G. Venkatachari, Progr. Org. Coat.59, 2007, P 291.

80. K.Ch.Changa, M.Ch.Laia, Ch.W.Penga, Y.T.Chena, J.M.Yeha, Ch.L.Linb and J.Ch.Yang, Electrochim. Acta 51, 2006, P 5645.

81. S.Syed Azim, S.Sathiyanarayanan and G.Venkatachari, Progr. in Org. Coatings 56, 2006, P 154.

82. S.Sathiyanarayanan, S.Muthukrishnan and G.Venkatachari, Synth. Met. 156, 2006, P 1208.

83. R.C. Patil and S. Radhakrishnan, Progr. in Org. Coatings 57, 2006, P 332.

84. E.Armelin, C.Ocampo, F.Lies, J.I.Iribarren, X.Ramis and C.Alemán, Progr. in Org. Coatings 58, 2007, P 316.

85. E.Armelin, R.Oliver, F.Liesa, J.I. Iribarren,F. Estrany and C. Alemán, Progr. in Org. Coatings 59, 2007, P 46.

86. J.E.Pereira da Silva, S.I.Córdoba de Torresi and R.M.Torresi, Progress in Org. Coatings 58, 2007, P 33.

87. J. Brodinová,J.Stejskal and A.Kalendová, J. Phys. and Chem. of Solids 68, 2007, P 1091.

88. J.Shine, J.C. McClure,R. Chianelli, P. Pich and P.J. Sebastian, Internat. J. Hydrogen Energy 30, 2005, P 1339.

89. M.A. Lucio García and Mascha A. Smit, J. Power Sources 158, 2006, P 397.

■