

Synthesis of π -Conjugated Conducting Polymers, Electrochemical Impedance Spectroscopy, Circuit Modelling and Sensor Applications

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In this study, *N*-carbazole, *N*-vinylcarbazole, *N*-thiophene, *N*-2-methylthiophene, 3-methylthiophene and newly synthesized 9-tosyl-9*H*-carbazole (TsCz) were electrocoated on carbon fiber microelectrodes (CFME) (diameter $\sim 7\ \mu\text{m}$) by cyclic voltammetry. Coatings of polymer thin films obtained, with different initial monomer concentrations, different solutions and thickness value, were characterized by cyclic voltammetry (CV), scanning electron microscopy (SEM) and Fourier transform infrared reflectance-attenuated total reflection spectroscopy (FTIR-ATR).

Capacitor behavior of modified CFME was studied by electrochemical impedance spectroscopy (EIS). The deposition charge of polymer growth affected the redox parameters of resulting coated CFME. The effects of the type of electrolyte and solvent on the electrochemical impedance spectroscopic data were subsequently fitted with an $((R(C(R(Q(RW)))))(CR)$ - equivalent circuit model to calculate the numerical values of the proposed components. The obtained specific capacitance (C_{sp}) values for Polycarbazole / CFME and Poly(*N*-vinylcarbazole) / CFME as measured in LiClO_4 / ACN were $280.5\ \text{mF g}^{-1}$ and $294.1\ \text{mF g}^{-1}$, respectively [1]. The 3-methylthiophene deposited electrode in the initial monomer concentration of 0.1 M exhibits high C_{sp} of $\sim 4.12\ \text{F g}^{-1}$ [2], in comparison with a value of $1.13\ \text{F g}^{-1}$ for thiophene in the initial monomer concentration of 0.5 M and $6.35\ \text{mF g}^{-1}$ for 2-methylthiophene in the initial monomer concentration of 0.2 M [3].

The capacitive behaviour of modified CFMEs was defined via Nyquist, Bode-magnitude, Bode-phase and Admittance plots. An equivalent electrical circuit $R(CR)(QR)(CR)$ for different concentrations of P(TsCz) /CFME was proposed an experimental data were simulated to obtain the numerical values of circuit components [4].

- References: [1] M.Ates, A.S.Sarac, J.Appl.Electrochem., 39 (2009) 2043-2048.
[2] M.Ates, Int.J.Electrochem.Sci., 4 (2009) 1004-1014.
[3] M.Ates, Int.J.Electrochem.Sci., 4 (2009) 980-992.
[4] M.Ates, N.Uludag, A.S.Sarac, Prog.Org.Coat. (in revision)(2010).

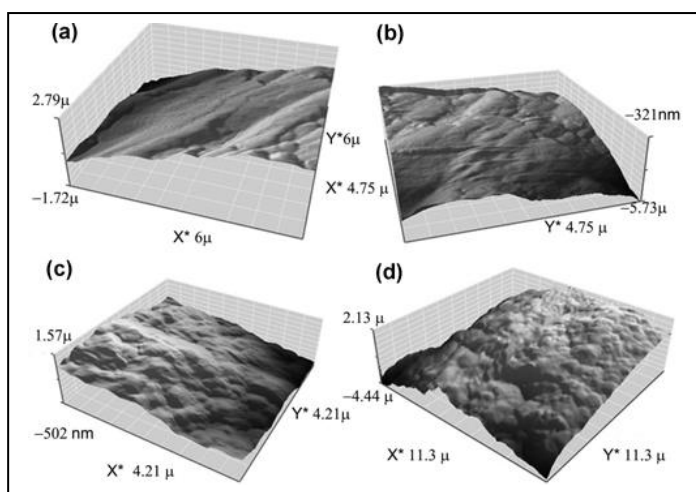


Fig. 1. AFM images of PCz coated CFME scan rate at $50\ \text{mV s}^{-1}$, $[\text{Cz}]_0 = 1\ \text{mM}$ in $0.05\ \text{M TEAP/CH}_2\text{Cl}_2$; (a) 3rd cycles ($5\ \mu\text{m} \times 5\ \mu\text{m}$), (b) 5th cycles ($4.75\ \mu\text{m} \times 4.75\ \mu\text{m}$), (c) 7th cycles ($4.2\ \mu\text{m} \times 4.2\ \mu\text{m}$), and (d) 10th cycles ($11.3\ \mu\text{m} \times 11.3\ \mu\text{m}$).