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Equivalent Circuit Models and Analysis of Electrochemical Impedance Spectra of Caffeine Solutions and Beverages

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In this study, a non-faradaic electrochemical impedance spectroscopy has been employed for estimation of caffeine concentration in beverages. Impedance spectra were recorded by using a two electrode system without adding any redox reagents in the measured solutions. Electrochemical impedance data of caffeine solutions in pure water and beverages were measured and an appropriate equivalent electrical circuit model is developed to help in this investigative analysis. The interaction of caffeine molecules with the electrodes was primarily correlated to the formation of electrical double-layer at modified interface. Overall system impedance (|Z|), inverse of solution resistance ($1/R_S$) and constant phase element of the system were further investigated from the equivalent electrical circuit and plotted as a function of pure caffeine concentration. Finally, the results obtained from spiked diluted cola beverages were compared with the pure caffeine sample.

Keywords: Caffeine, Impedance Spectroscopy, Circuit modeling

FULL TEXT