Impedance Analysis of Adsorption of Adrenochrome in Electrochemical Reduction

Zhanjun Zhang[1,2],Xizun Wu[3],Wenzhi Zhang[3],and Shengmin Cai[2,*]
[1]Graduate School of Chinese Academy of Sciences, Beijing 100039, China;
[2]College of Chemistry and Molecular Engineering, Peking University, Bejing 100871, China;
[3]Department of Chemistry, Hebei Teacher's University, Shijiazhuang, Hebei, 050016, China.

Adrenochrome (adrom) is a metabolic pathway for adrenaline (adin) in organism. Its physiological functions have much to do with its redox reactions, so study of the mechanism of redox reactions of adrom are of great significance. Previous studies showed that the electrode process of adrom was accompanied by adsorption (1,2). In the present study, complex capacitance model is used trying to analyze the adsorption effect in the electrode process.

Experimental

A three-electrode system was used. A glassy carbon disc electrode with an area of 0.196 cm^2 was the working electrode. A saturated calomel electrode connected through a Luggin capillary was used as the reference electrode, vs. which potentials were reported. Large-area platinum foil was used as the auxiliary electrode. McIlvaine buffer solution with constant ionic strength 1.0 (pH 5.20) was used as the electrolyte.The concentration of adrom was 6.0×10^{-5} $moldm^{-3}$.The tests were made at room temperature.

Results and Discussion

In the studied potentials , all the complex admittance plots of electroreduction of adrom have the similar shape, seen in Fig.1. According to the measured impedance spectroscopy of electro reduction of adrom, an appropriate equivalent circuit is suggested and the response of both the real and imaginary parts of the model to a.c. frequency have been discussed. Nonlinear curve fitting was made based upon the equivalent circuit expressed in Fig.2,in which element C was expressed in a complex capacitance. Very good regressive results were obtained. The optimal estimation for some parameters showed in tables 1-3.

ACKNOWLEDGMENTS

We gratefully acknowledge support of the National Natural Science Foundation of China (No.20073003) , the Research Fund for the Doctoral Program of Higher Education of China (No.98000117), the Fund of Postdoctoral Scientific Research of China .

REFRENCES

1. Zhanjun Zhang, Xizun Wu and Wenzhi Zhang, J. Electroanal. Chem.,**444**,169(1998)
2. Zhanjun Zhang,Xizun Wu,Wenzhi Zhang, J. Electrochem. Soc.，**146**，256（1999）

*Correspondent:caism@chem.pku.edu.cn

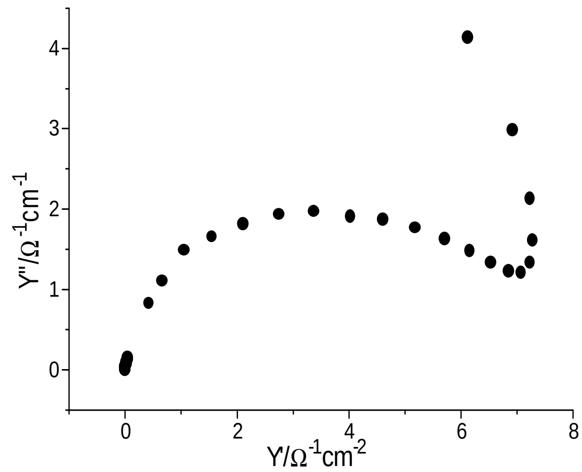

Fig.1. Admittance plot for electroreduction of adrenochrome in Mallvane buffer solution at -105mV.pH=5.20. Concentration:$6.0*10^{-5}moldm^{-3}$.

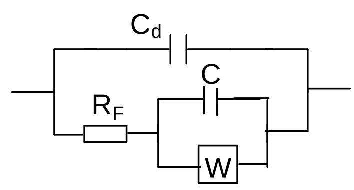

Fig.2 Equivalent circuit

Table 1. The optimal fitting function and the optimal estimation for parameter Cd=f(ω ; θ_i) *

φ	Cd=α[1−exp (−β/ω^K)]			
mV	α	β	K	R.S.D
−75	3.83×10^{-4}	$2.47\times10^{+1}$	9.01×10^{-1}	8.83×10^{-7}
−105	3.73×10^{-4}	$2.23\times10^{+1}$	8.77×10^{-1}	1.50×10^{-6}
−195	4.49×10^{-4}	$2.10\times10^{+1}$	8.75×10^{-1}	1.14×10^{-6}

* θ_i=α,β,K , R.S.D:Residual standard deviation

Table 2. The optimal fitting function and the optimal estimation for parameter R_f=f(ω ; θ_i) *

φ	R_f =α – βexp (−γ/ω)			
mV	α	β	γ	R.S.D
−75	3.38	1.84	1.161×10^{2}	6.38×10^{-2}
−105	3.27	1.76	1.137×10^{2}	5.73×10^{-2}
−195	3.65	2.28	1.024×10^{2}	6.73×10^{-2}

* θ_i=α,β,γ R.S.D:Residual standard deviation

Table 3. The optimal fitting function and the optimal estimation for parameter Y_w=f(ω ; θ_i) *

φ	Y_w =α + βexp (−γ/ω)			
mV	α	β	γ	R.S.D
−75	2.91×10^{-3}	$8.42\times10^{+3}$	6.09×10^{3}	8.18×10^{-4}
−105	2.98×10^{-3}	$7.76\times10^{-3}7$	5.47×10^{3}	7.74×10^{-4}
−195	2.79×10^{-3}	$.71\times10^{-3}$	4.37×10^{3}	7.42×10^{-4}

* θ_i=α,β,γ R.S.D:Residual standard deviation