Electrochemical Investigations of Benzanthrone

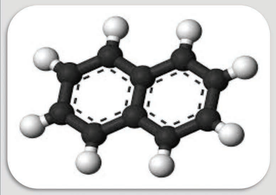
Antonio Trevino and Kefa K. Onchoke
Department of Chemistry
Stephen F. Austin State University, TX 75962

1. Abstract

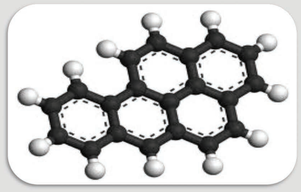
- Cyclic Voltammetry (CV) and differential pulse voltammetry (DPV) of benzanthrone, an environmental pollutant, was studied in an acetonitrile solution with a 0.15 M tetrabutylammonium hexafluorophosphate as the background electrolyte.
- Benzanthrone concentrations of 0.5, 1.0, 1.5, and 2.0 mM were studied at 50, 100, 200, 500, 1000 and 2000 mV/s scan rates, or n.
- With increase in scan rates up to 200 mV/s the reversibility of benzanthrone began shifting, indicating a change in the electron transfer rate constants for low concentration solutions.
- At higher scan rates (500 - 2000 mV/s), quasi-reversible reactions, i.e. $I_{pc} / I_{pa} > 1.5$, were observed.
- For the 0.5 and 1.0 mM benzanthrone concentrations and higher scan rates, the reductive reaction at the surface of the electrode is not diffusion-controlled alone.
- At higher concentrations (1.5 and 2.0 mM), the cathodic peak/ anodic peak current ratio (I_{pc}/ I_{pa}) stays close to one, with average I_{pc}/I_{pa} ratios of 0.986 and 1.161 respectively, indicating a diffusion controlled, reversible reaction at the electrode surface.

2. Reasons for Study

1. Polycyclic aromatic hydrocarbons, PAHs, contain multiple fused aromatic rings such as benzene.



Naphthalene



Benzo(a)pyrene

2. PAH form from the incomplete combustion of solid and liquid fuels such as coal, kerosene, and wood, as well as other organic matter.

3. These compounds are found everywhere and many people are at risk of exposure.

3. Materials and Methods

3.A. Methods

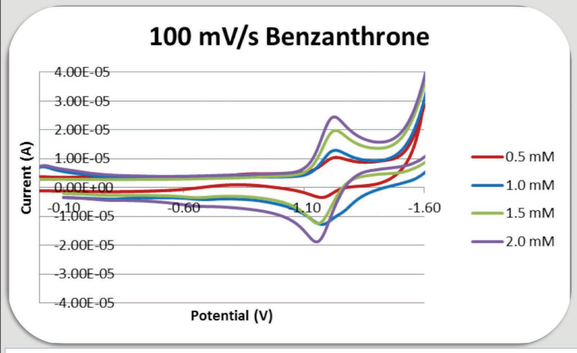
1. Cyclic Voltammetry
2. Differential Pulse Voltammetry

3.B. Materials

1. Benzanthrone, Sigma Aldrich, 98.0% purity
2. Acetronitrile, EM Science, 99.93% HPLC grade
3. Tetrabutylammonium hexafluorophosphate, Fluka Analytical, 99.0%

4. Results /Data

4.A. Cyclic Voltammetry

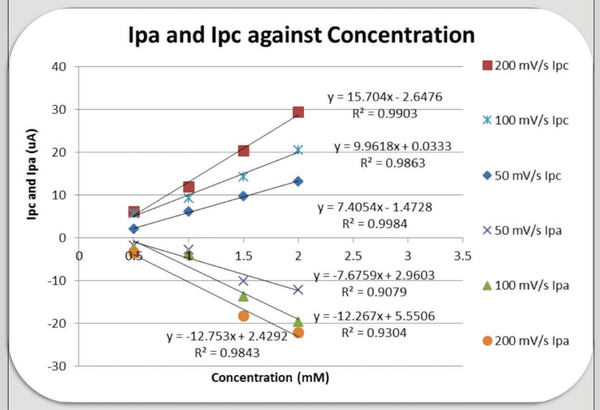


1.5 mM Benzanthrone

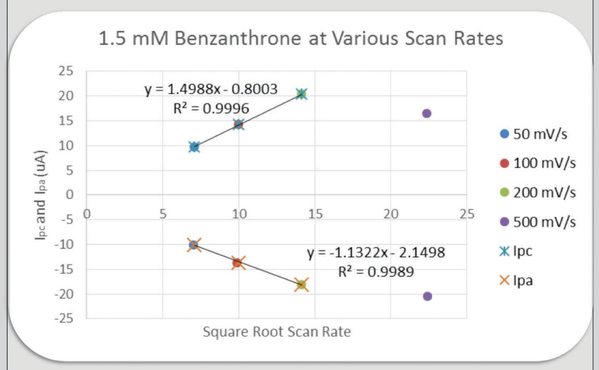
Scan Rate	(Scan Rate) ^1/2	Ipc	Ipa	Ipc/Ipa
50.00	7.07	9.72	10.06	0.97
100.00	10.00	14.32	13.63	1.05
200.00	14.14	20.34	18.10	1.12
500.00	22.36	16.40	20.40	0.80

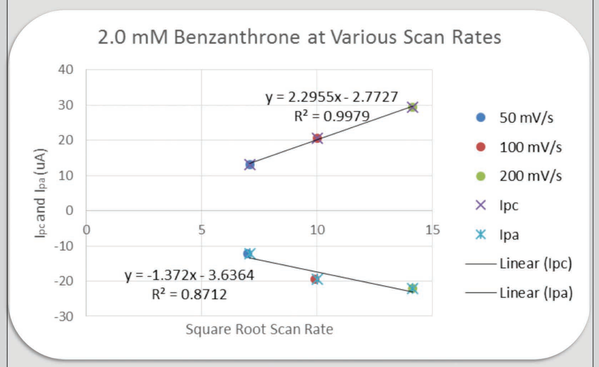
4. Data (continued)

4.B. Differential Pulse Voltammetry (D.P.V.)



4.C. Shifting Reversibility





Linearity up to 200 mV/s is consistent with all of the concentrations, showing a reversible reaction until the scan rate increases beyond 200 mV/s.

5. Conclusion

•As concentration increased, the peak values Ipc and Ipa increase as expected for all of the concentrations tested, 0.5, 1.0, 1.5, and 2.0 mM of benzanthrone.

•The shift in linearity of Ipc and Ipa v.s. square root of scan rate above 200 mV/s indicates a shift in the reversibility of the reduction/oxidation.

•The lowest limit of detection was determined to be 0.169 mM, confirming that the concentrations used in this study would be electrochemically active using D.P.V.

•Overall, the electron transfer that occurs in benzanthrone when potential is applied begins to shift as scan rate increases. This could be a change in the mechanism of the electron transfer. The higher scan rates, +500 mV/s, produced irreversible electron behavior .

References

- Kissinger, Peter T. *Cyclic Voltammetry.* Journal of Chemical Education. 60 (9). 702-706. 1983.
- Yue, Ruirui, Xu, Jingkun, Lu, Baoyang, Liu, Congcong, Li, Yuzhen, Zhu, Zhaojin, and Chen, Shuai. *Electrochemical copolymerization of benzanthrone and 3-methylthiophene and characterization of their fluorescent copolymer.* Journal of Materials Science. 44 (2009). 5909-5918. 2009.
- Singh, G.B., and S.H. Zaidi. *Preliminary clinical and experimental studies on benzanthrone toxicity*. J. Indian Med. Assoc. 1969.
- Pandey, K.M., and Das, M. *Assessment of carcinogenic potential of repeated fish fried oil in mice.* Food, Drug, and Chemical Toxicology. 45 (10). 741-51. 2006.

Acknowledgements

Special Thanks to:
Chemistry Department, SFASU
Dr. Kefa Onchoke

Funding
Robert A. Welch Foundation: AN-0008
Department of Chemistry, SFASU
ORSP # 114110, # 107552, and Research mini-grants