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OBSERVATIONS ON THE EFFECT OF SELECTED ORGANIC
MATERIALS ON THE USABLE POTENTIAL RANGES OF
THE GLASSY CARBON, PYROLYTIC GRAPHITE,
AND PLATINUM ELECTRODES

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Observations on the Effect of Selected Organic Materials on the Usable Potential Ranges of the Glassy Carbon, Pyrolytic Graphite, and Platinum Electrodes

Carl E. Plock

Abstract. The effect of several organic materials on the usable potential ranges of the glassy carbon, pyrolytic graphite, and platinum wire electrodes is reported.

INTRODUCTION

Beilby et al. (1), found the usable potential range of the pyrolytic graphite electrode in 0.5M potassium chloride to be +1.3 to -1.6 volts versus saturated calomel electrode. The usable potential range of the glassy carbon electrode in acid media was determined as +1.2 to -0.8 volts versus saturated calomel electrode by Zittel and Miller (2).

During the investigation of neptunium (VI) complexes at the glassy carbon electrode and at the pyrolytic graphite electrode (3-6), it was apparent that the ligand and the pH of the solution were influencing the usable potential ranges of these electrodes. It was therefore decided to determine the usable potential ranges of these electrodes and, in addition, a platinum wire electrode, in a number of organic materials.

SUMMARY

The effect of disodium malonate, disodium glutamate, sodium glycinate, disodium succinate, trisodium nitriloacetate, tetrasodium ethylenediaminetetraacetate, disodium iminodiacetate, sodium lactate, triethanolamine, 1,3-propanediamine, diisopropylamine and trisodium citrate at various pH values on the usable potential ranges of the glassy carbon electrode, pyrolytic graphite electrode, and a platinum wire electrode has been tabulated.

EXPERIMENTAL

Apparatus: All voltammograms were obtained at 25°C with a Sargent Model XV recording polarograph. The electrolysis cell (3,7), the glassy carbon electrode (GCE) (3,7), and the pyrolytic graphite electrode (PGE) (8,9), have been described. The platinum electrode (PtE) was a Sargent (S-29414) platinum wire electrode with a surface area of 0.07 cm².

The pH values of the solutions were measured using a Beckman Model H-2 pH meter and a glass electrode. The pH was adjusted with perchloric acid or sodium hydroxide.

Reagent: The organic reagents were "Baker" or "Baker Analyzed" except the iminodiacetic acid (City Chemical Corporation, U.S.A.). The other chemicals were reagent grade and prepared in the usual manner. Purified nitrogen was used to deaerate the test solutions.

DISCUSSION

The solutions were 0.5M in sodium perchlorate and contained the organic ligand at various pH values. The solutions were electrolyzed at the stationary electrode using a starting potential of 1.500 volts versus the saturated calomel electrode. The scan rate was 300 mV/min.

The effects of selected organic materials on the usable potential range are shown in Table I. The organic materials that were chosen are to be used in the investigation of the voltammetry of the neptunium(VI) and plutonium(VI) complexes at the glassy carbon electrode and the pyrolytic graphite electrode. Each organic had a different effect on each electrode function. An exception to this, however, is the malonate ion which had the same effect on each electrode function, 29 mV/pH. At the other extreme, the electrode function of the GCE in the presence of the succinate ion is 62 mV/pH whereas the electrode function of the PGE is 14 mV/pH.

These data will be an aid in selecting the proper electrode for the investigation to be performed.

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2. H. E. Zittel and F. J. Miller, *Anal. Chem.*, **37**, 200 (1965).
3. C. E. Plock, *J. Inorg. Nucl. Chem.*, in press.

Table I. Effect of pH and ligand on potential ranges of the glassy carbon, pyrolytic graphite, and platinum wire electrodes.

Organic Compound	Organic Concn (M)	pH	Potential Range versus S.C.E.		
			GCE	PGE	PtE
Na ₂ Malonate	1.0	1.0	1.1 to -1.1	1.2 to -1.0	1.2 to 0.3
		3.2	1.0 to -1.1	1.2 to -1.1	1.2 to 0.3
		5.8	1.0 to -1.3	1.2 to -1.2	1.2 to 0.3
		8.0	0.9 to -1.3	1.0 to -1.3	1.0 to 0.2
Na ₂ Glutamate	0.67	4.5	1.2 to -1.0	1.2 to -1.0	1.3 to 0.3
		6.8	1.1 to -1.1	1.2 to -1.0	1.2 to 0.3
		9.3	0.9 to -1.2	1.0 to -1.1	1.0 to 0.2
		11.6	0.75 to -1.2	0.9 to -1.3	0.9 to 0.0
Na Glycinate	1.0	1.0	1.2 to -1.0	1.2 to -1.0	1.3 to 0.5
		2.6	1.2 to -1.0	1.1 to -1.0	1.3 to 0.5
		5.6	1.0 to -1.2	1.0 to -1.2	1.2 to 0.3
		8.8	0.8 to -1.3	1.0 to -1.2	1.1 to 0.0
Na ₂ Succinate	0.8	4.2	1.2 to -1.2	1.1 to -1.0	1.3 to 0.3
		6.8	1.0 to -1.2	1.1 to -1.1	1.1 to 0.2
		9.4	0.9 to -1.3	1.0 to -1.1	1.0 to 0.0
		11.5	0.75 to -1.3	1.0 to -1.2	0.9 to 0.0
Na ₃ NTA	0.65	3.4	0.7 to -0.9	0.7 to -0.9	0.9 to 0.3
		8.2	0.4 to -1.2	0.45 to -1.2	0.6 to 0.1
		10.2	0.3 to -1.3	0.4 to -1.3	0.6 to 0.0
Na ₄ EDTA	0.6	6.2	0.6 to -1.0	0.6 to -1.2	0.8 to 0.0
		8.7	0.6 to -1.1	0.6 to -1.2	0.7 to 0.0
		11.6	0.6 to -1.3	0.6 to -1.2	0.6 to 0.0
Na ₂ IMDA ^a	0.5	2.2	1.0 to -0.9	1.1 to -0.9	1.1 to 0.4
		7.3	0.75 to -1.2	0.75 to -1.2	0.9 to 0.2
		12.0	0.45 to -1.3	0.5 to -1.3	0.6 to 0.0
Na Lactate	1.0	2.5	1.1 to -0.9	1.1 to -0.9	1.2 to 0.4
		5.0	1.1 to -1.1	1.1 to -0.9	1.2 to 0.2
		7.4	1.0 to -1.2	1.0 to -0.9	1.1 to 0.0
		10.0	0.9 to -1.2	0.9 to -1.1	1.0 to 0.0
TEA ^b	1.0	2.0	0.9 to -0.9	1.0 to -0.9	1.2 to 0.5
		4.8	0.7 to -1.0	0.8 to -1.0	0.9 to 0.3
		7.8	0.5 to -1.2	0.6 to -1.2	0.7 to 0.0
		10.2	0.3 to -1.2	0.45 to -1.3	0.5 to 0.0
1,3-DAP ^c	1.0	7.5	0.9 to -1.3	0.9 to -1.2	1.0 to 0.1
		10.0	0.75 to -1.2	0.7 to -1.2	0.9 to 0.0
		11.7	0.7 to -1.3	0.7 to -1.2	0.9 to 0.0
DIPA ^d	1.0	1.0	1.1 to -0.9	1.1 to -0.9	0.8 to 0.4
		8.5	0.6 to -1.0	0.6 to -1.1	0.6 to 0.1
		11.6	0.3 to -1.2	0.3 to -1.2	0.45 to 0.0
Na ₃ Citrate	0.8	4.8	0.9 to -1.1	1.0 to -1.0	1.2 to 0.3
		5.7	0.9 to -1.1	0.9 to -1.1	1.1 to 0.3
		8.7	0.7 to -1.1	0.7 to -1.1	1.0 to 0.2

^a Disodium Iminodiacetate^b Triethanolamine^c 1,3-Propanediamine^d Diisopropylamine4. C. E. Plock, *Anal. Chim. Acta*, in press.

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