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CHEMISTRY IN NONAQUEOUS SOLVENT SYSTEMS
A TEN-YEAR ANNOTATED BIBLIOGRAPHY

William R. Strickland

THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION
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ABSTRACT

The open literature for the past decade has been surveyed for accounts of explorations in nonaqueous (organic) solvent systems. Those references pertinent to programs under consideration at Rocky Flats have been tabulated and annotated.

INTRODUCTION

Despite the fact that consistent theoretical considerations are often lacking, considerable time and effort have been spent in the past decade on studies in nonaqueous, organic solvent systems. A good deal of this effort has been prompted in part by the NASA programs for the development of high energy-density primary battery systems. Much of it, however, has been stimulated simply because the solvent of universal choice, water, is unsuitable for many studies. Other efforts have been made in an attempt to correlate nonaqueous solvent systems with aqueous systems and thus fill a theoretical void.

A detailed discussion of the reasons for choosing a particular solvent would not be in keeping with the spirit of briefness of this introduction. The requirements are as varied as are the studies which are performed. In one instance, a high solvent dielectric constant for wider charge separation is preferred; in another, a lower dielectric constant allowing the formation of dimers, trimers or polymers is preferred. In still other instances, the dielectric constant is of no consequence; chemical or electrical stability or ease of purification and handling is more important.

This bibliography, which graphically depicts the myriad possibilities for nonaqueous solvent systems, was compiled in support of inorganic and electrochemical studies under consideration here at Rocky Flats. A time span of ten years was arbitrarily chosen, with no reflectance intended on the considerable amount of work completed before that time.

Comments are purposefully brief, and subject and author indices are provided. The compilation is not all inclusive, but it does provide a stepping stone from which other efforts may be made.

CHEMISTRY IN NONAQUEOUS SOLVENT SYSTEMS

A TEN-YEAR ANNOTATED BIBLIOGRAPHY

William R. Strickland

JOURNAL ARTICLES AND GOVERNMENT REPORTS

Abstract No.

1. E. S. Amis. THE DEPENDENCE OF THE STANDARD POTENTIAL OF GALVANIC CELLS ON THE DIELECTRIC CONSTANT OF SOLVENTS. *J. Electroanal. Chem.*, **8**, 413-8 (1964).
A general equation relating E° to $1/D$ was developed and illustrated by data taken from cells with bi-univalent and uni-univalent electrolyte systems.
2. E. M. Arnett and C. F. Douty. SOLVENT EFFECTS IN ORGANIC CHEMISTRY. II. SULFOLANE - A WEAKLY BASIC APROTIC SOLVENT OF HIGH DIELECTRIC CONSTANT. *J. Am. Chem. Soc.*, **86**, 409-12 (1964).
Sulfolane appears to have all the advantages of MeNO_2 , in addition to being easier to purify.
3. V. E. Arnold. NONAQUEOUS ELECTROPLATING TO ELIMINATE HYDROGEN EMBRITTLEMENT. SC-RR-66-507, Septemeber 1966, 21 pages.
Copper and nickel electroplating baths of DMSO, DMF and 1,2-ethanediol are described.
4. K. W. Bagnall, D. Brown, D. H. Halah, and F. Lux. DIMETHYL SULPHOXIDE COMPLEXES OF THE ACTINIDE TETRACHLORIDES. *J. Chem. Soc.*, **1968** (A), 465-70.
Adducts of the form $\text{MCl}_4 \cdot 7\text{DMSO}$ ($\text{M} = \text{U}, \text{Np}$ and Pu), $\text{MCl}_4 \cdot 5\text{DMSO}$ ($\text{M} = \text{Th}, \text{Pa}, \text{U}, \text{Np}$), and $\text{MCl}_4 \cdot 3\text{DMSO}$ ($\text{M} = \text{Th}, \text{Pa}, \text{U}, \text{Np}$ and Pu) were prepared. Chemical and physical properties and infrared spectra are presented and discussed.
5. K. W. Bagnall, A. M. Deane, T. L. Markin, P. S. Robisonn, and M. A. A. Stewart. SOME ACETAMIDE COMPLEXES OF THE ACTINIDE TETRACHLORIDES. PART I. URANIUM, NEPTUNIUM, AND PLUTONIUM. *J. Chem. Soc.*, **1961**, 1611-7.
Preparation of ionic compounds of the general formula $\text{MCl}_4 (\text{AcNH}_2)_6$ and $\text{MCl}_4 [\text{Ac}(\text{CH}_3)_2]_2$ (where $\text{M} = \text{U}, \text{Np}$ or Pu) from the metal halide salt and anhydrous acetamide or N, N-dimethyl-acetamide. Infrared spectra, thermal degradation curves and x-ray powder diffraction patterns were taken.
6. V. P. Barabanov. ELECTROLYTIC PURIFICATION OF ORGANIC SOLVENTS FROM IONIC IMPURITIES AND FROM WATER. *Zh. Fiz. Khim.*, **37**, 710-11 (1963).
A modified Hittorf tube is used in this procedure.
7. K. Barnes and C. K. Mann. DIMETHYLSULFOXIDE AS SOLVENT FOR ACIDIMETRIC DETERMINATION OF AMMONIUM AND SUBSTITUTED AMMONIUM IONS. *Anal. Chem.*, **36**, 2502-3 (1964).
A satisfactory analysis of NH_4^+ and substituted NH_4^+ consists of dissolving the NH_4^+ salt in DMSO and titrating, using a glass-calomel electrode system.
8. R. C. R. Barreto and H. S. R. Barreto. SPECTROPHOTOMETRIC ASSAY OF WATER IN ORGANIC SOLVENTS. *Anal. Chem. Acta.*, **26**, 494-5 (1962).
A method is illustrated for determining ≥ 2 percent water with a relative error of 1.5 percent.
9. F. G. K. Bauchke, D. Landolt, and C. W. Tobias. ROTATING DISC SYSTEM FOR THE STUDY OF METAL DEPOSITION FROM NONAQUEOUS SOLVENTS. UCRL 17957, December 1967, 32 pages.
This system was designed especially for work being conducted in an inert atmosphere. Also reported are results of attempts to electrodeposit potassium and calcium from propylene carbonate.
10. F. G. K. Baucke and C. W. Tobias. THALLIUM-THALLOUS HALIDE REFERENCE ELECTRODES IN PROPYLENE CARBONATE. UCRL-17892, June 1967, 12 pages.

This satisfactory electrode system was evaluated in terms of bias potential, polarization measurements and solubilities, and with intercomparison of cells without transference and cells in aqueous solutions.

11. J. P. Bibler and D. G. Kanaker. DIETHYLDITHIO-CARBONATES OF QUADRIVALENT ACTINIDES. *Inorg. Chem.*, 7, 982-5 (1968).
Prepared $M [S_2 CN (C_2H_5)_2]_4$, $M = Th, U, Np$ and Pu , from $MC14$ or $M [C_2H_5)_4-N]_2$ and $LiS_2CN (C_2H_5)_2$ in anhydrous ethanol. Infrared spectra, proton magnetic resonance spectra and x-ray diffraction data were taken.
12. C. V. Birney and J. H. Weber. COMPLEXES OF SULFOXIDES. II. METAL-OXYGEN STRETCHING VIBRATIONS IN COMPLEXES OF DIMETHYL SULFOXIDE AND DIMETHYL SULFOXIDE- d_6 AND THE POINT GROUP OF THE CATION. *Inorg. Chem.*, 7, 283-7 (1968).
Infrared spectroscopic data suggest the cation point group to be S_6 .
13. E. Blasius and F. Wolf. ION-EXCHANGE IN WATER-LIKE SOLVENTS. *Z. Anal. Chem.*, 171, 88-90 (1959).
 $AcNHLi$ and $LiOAc$ were prepared by passing $AcNHNa$ in $AcNH_3$ - $AcNHMe$ over a strongly acid cation exchange resin.
14. P. W. Brewster, F. C. Schmidt, and W. B. Schapp. CONDUCTANCE MEASUREMENTS OF THE HALIDES, NITRATES AND NITRITES OF THE ALKALI METALS IN ANYDROUS ETHANOL-AMINE. *J. Am. Chem. Soc.*, 81, 5532-5 (1959).
Fifteen salts were examined with Onsager slopes determined and Kohlrausch law confirmation. The trend of the limiting conductivity of the anions and cations are: $Li(Na(K, I)BrCl)$.
15. G. Briere and G. Pierre. ELECTRODIALYSIS OF POLAR SOLVENTS. I. GENERAL STUDY OF THE ELECTRICAL PROPERTIES OF SELECTIVE MEMBRANES. *J. Chem. Phys.*, 959 (1965) (Fr.).
The behavior of three types of semipermeable membranes were compared in aqueous and organic electrolyte solutions.
16. J. M. Brooks and R. R. Dewald. ADSORPTION SPECTRA OF THE ALKALI METALS IN HEXAMETHYLPHOSPHORAMIDE. *J. Phys. Chem.*, 72, 2655-2659 (1968).
All five metals (Li, Na, K, Rb, Cs) have an identical absorption peak at $2250 m\mu$ with other differentiating maxima also. Temperature and alkali metal halide salt addition effects were also studied.
17. D. Brown. ANYDROUS HEXACHLORO- AND HEXABROMO-COMPLEXES OF QUADRIVALENT THORIUM, URANIUM AND NEPTUNIUM. *J. Chem. Soc.*, 1966, (A), 766-9.
Reaction of $MX_4 \cdot 4CH_3CN$ ($M = Th$ and U ; $X = Cl$ and Br) with R_4NX ($R = CH_3$ or CH_3CH_2) in anhydrous methyl cyanide gives $(R_4N)_2 ThCl_6$, $(R_4N)_2 ThBr_6$ and $(R_4N)_2 UBr_6$. Infrared spectra and x-ray diffraction data are reported.
18. W. E. Bull, S. K. Madan, and J. E. Willis. AMIDES AS LIGANDS. I. METALLIC COMPLEXES OF N, N-DIMETHYLACETAMIDE. *Inorg. Chem.*, 2, 303-6 (1963).
Infrared spectra, electrical conductance, melting point, and magnetic moment data were all used to characterize 26 different addition compounds.
19. B. Burrows and R. Jasinski. THE Li/Li^+ REFERENCE ELECTRODE IN PROPYLENE CARBONATE. *J. Electrochem. Soc.*, 115, 365-7 (1968).
Three types of Li/Li^+ electrodes were evaluated in $1M$ $LiClO_4$ -PC solutions. Best performance was given by a Li ribbon.
20. B. Burrows and Susan Kirkland. ELECTROCHEMICAL BEHAVIOR OF H_2O IN NONAQUEOUS ELECTROLYTE. *J. Electrochem. Soc.*, 115, 1164-9 (1968).
Chronopotentiometric and cyclic voltammetric studies of 1-30 $m\mu$ of water in propylene carbonate - $LiClO_4$ solutions indicate a strong solvation of Li^+ by water and a subsequent formation of insoluble and passive $LiOH$ on the electrode surface.
21. J. N. Butler. SOLUBILITY AND COMPLEX FORMATION EQUILIBRIA OF SILVER CHLORIDE IN PROPYLENE CARBONATE. *Anal. Chem.*, 39, 1799-1804 (1967).
Solubility of $AgCl$ in PC-excess Cl^- solution is evaluated.
22. J. N. Butler, D. R. Cogley, and W. Zurosky. SOLUBILITY AND COMPLEX FORMATION OF $AgCl$ IN PROPYLENE CARBONATE-WATER MIXTURES.

- J. Electrochem. Soc.*, **115**, 445-9 (1968).
Potentiometric studies indicate the principle species is AgCl_2^- . Solubility constants, complex formation constants and empirical expressions are developed.
23. H. Chateau and Marie Moncet. CONDUCTIVITY OF AgNO_3 IN DIMETHYLFORMAMIDE. *Compt. Rend.*, **252**, 2975-7 (1961).
Kohlrausch-Onsager plots of equivalent conductivity vs. $\sqrt{c}$ indicate that AgNO_3 is incompletely dissociated in DMF. Bjerrum - Fuoss calculations indicate that the ions are not solvated.
24. E. L. Childs and F. E. Evans. NONAQUEOUS ELECTROPLATING BATH FOR URANIUM. *Plating*, **164-7** (February 1968).
An uranium electropolishing bath of 1,2-ethanediol and sodium hypophosphite and procedures for its use are described.
25. L. I. Chudinova. PREPARATION AND PROPERTIES OF COMPOUNDS OF LEAD PERCHLORATE WITH PHYRIDINE. *Russian J. Inorg. Chem.* (English Trans.), **12**, 1778-80 (1967).
Addition compounds of the sort $\text{Pb}(\text{ClO}_4)_2 \cdot n\text{Py}$ ($n = 1, 2, 4$) were prepared and some of their physical properties were studied. An anhydrous form of $\text{Pb}(\text{ClO}_4)_2$ was prepared by heating hydrated $\text{Pb}(\text{ClO}_4)_2$ in a vacuum with pyridine.
26. J. F. Coetzee and Wei-San Siao. POLAROGRAPHY OF THE RARE EARTH ELEMENTS AND OTHER INORGANIC SUBSTANCES IN ACETONE AS SOLVENT. *Inorg. Chem.*, **2**, 14-19 (1963).
Comparisons are made between this data and similar data for solvent systems of water and acetonitrile. In general, half-wave potentials are less negative in acetone, but the disadvantages (hygroscopicity, flammability, etc.) are detrimental to its use in practical polarography.
27. F. A. Cotton and R. Francis. SULFOXIDES AS LIGANDS. I. A PRELIMINARY SURVEY OF METHYL SULFOXIDE COMPLEXES. *J. Am. Chem. Soc.*, **82**, 2986-2991 (1960).
Data for a large number of metal salt-DMSO adducts are reported. Reflectance spectra, dipole and magnetic measurements and preparation schemes are given.
28. F. A. Cotton and R. Francis. SULPHOXIDES AS LIGANDS. PART III. DIMETHYLSULPHOXIDE COMPLEXES OF Co (II) AND Ni (II) CONTAINING TETRAHEDRAL TETRAHALO IONS. *J. Inorg. Nucl. Chem.*, **17**, 62-8 (1961).
Ten unusual compounds were formed. Evaluation of spectral and magnetic data lead to structural assignments such as these: $[\text{Co}(\text{DMSO})_6]$ $[\text{CoI}_4]$ and $[\text{Ni}(\text{DMSO})_6]$ $[\text{NiBr}_4]$.
29. W. F. Currier and J. H. Weber. COMPLEXES OF SULFOXIDES I. OCTAHEDRAL COMPLEXES OF MANGANESE (II), IRON (II), COBALT (II), NICKEL (II) AND ZINC (II). *Inorg. Chem.*, **6**, 1539-43 (1967).
Eighteen octahedral complexes were prepared from hydrated perchlorate salts of these metals and various sulfoxide ligands. Infrared spectra and magnetic susceptibility measurements are given.
30. A. N. Dey. ELECTROCHEMICAL STUDIES ON THE EFFECTS OF WATER IN NONAQUEOUS ELECTROLYTES. *J. Electrochem. Soc.*, **114**, 824-5 (1967).
In propylene carbonate, water preferentially solvates the cation. If the solvation requirements are fully met, the water of solvation may preclude electro-deposition of the metal.
31. J. T. Donaghue and R. S. Drago. NONAQUEOUS COORDINATION PHENOMENA - COMPLEXES OF HEXAMETHYLPHOSPHORAMIDE. I. PREPARATION AND PROPERTIES OF TETRAHEDRAL $[\text{Zn}(\text{PO}[\text{N}(\text{CH}_3)_2]_3)_4]^{+2}$, $[\text{Co}(\text{PO}[\text{N}(\text{CH}_3)_2]_3)_4]^{+2}$, and $[\text{Ni}(\text{PO}[\text{N}(\text{CH}_3)_2]_3)_4]^{+2}$ COMPOUNDS. *Inorg. Chem.*, **1**, 866-72 (1962).
The preparation and structure of these interesting tetrahedral complexes are discussed. Electronic absorption data is given and ligand field and electronic parameters are discussed.
32. J. S. Dunnett and R. P. H. Gasser. ELECTROLYTE SOLUTIONS IN DIMETHYL SULFOXIDE. PART I. LITHIUM CHLORIDE. *Trans. Faraday Soc.*, **61**, 922-7 (1965).
Activity coefficients, conductivity and viscosity data and N.M.R. spectra are reported for LiCl in DMSO.

33. E. D. Eastman and B. J. Fontana. ELECTROLYSIS OF NON-AQUEOUS SOLUTIONS OF URANIUM BROMIDES; AND REACTION OF ALKALI METALS WITH URANIUM BROMIDES IN LIQUID AMMONIA. MDDC-1579, 15 pages.
Attempts were made to electrodeposit uranium from a variety of organic solvents with metallic deposits noted only from acetamide, formamide, and ethyl alcohol. Ammoniacal adducts of uranium tetrabromide were prepared by treatment of the salt with dry, liquid ammonia.
34. P. G. T. Fogg. SOLVATION OF CALCIUM NITRATE AND OF LITHIUM PERCHLORATE IN ACETONE MEASURED BY ULTRASONIC METHOD. *J. Chem. Soc.*, (1958), 4111-3.
Solvated complexes of the salts were investigated by measurement of ultrasonic velocity through the solutions, and by spectroscopic techniques.
35. G. Fraenkel, S. H. Ellis, and D. T. Dix. HEXAMETHYLPHOSPHORAMIDE. AN APROTIC SOLVENT FOR ACTIVE METALS. *J. Am. Chem. Soc.*, 87, 1406-7 (1965).
Li, Na, and K dissolve in HMPA to give blue solutions, typical of the NH_3 -solvated electron solutions. Grignard reagents and organolithium compounds may be prepared in HMPA.
36. J. S. Fritz and Marcia L. Gillette. ANION EXCHANGE SEPARATION OF METAL IONS IN DIMETHYL SULPHOXIDE - METHANOL - HYDROCHLORIC ACID. *Talanta*, 15, 287-97 (1968).
Distribution coefficients for 26 elements were determined in varying ratios of DMSO and MeOH, in HCl. Quantitative separations were obtained in 27 anion-exchange procedures with two-to-four component mixtures being used.
37. R. M. Fuoss and E. Hirsch. SINGLE ION CONDUCTANCES IN NON-AQUEOUS SOLVENTS. *J. Am. Chem. Soc.*, 82, 1013-17, (1960).
Conductances of tetrabutylammonium tetraphenylboride in propylene carbonate and in mixtures of nitrobenzene and carbon tetrachloride were measured. Ion-ion distance parameters were calculated from three methods.
38. A. D. Goolsby and D. T. Sawyer. THE ELECTROCHEMICAL OXIDATION OF HYDROXYLAMINE AT PLATINUM AND GOLD ELECTRODES IN DIMETHYLSULFOXIDE. *J. Electroanal. Chem.*, 19, 405-11 (1968).
Chronopotentiometry, controlled-potential coulometry and cyclic voltammetry were used in this characterization. Diffusion coefficients under ideal conditions were determined and possible oxidation mechanisms were postulated.
39. A. D. Goolsby and D. T. Sawyer. THE ELECTROCHEMICAL REDUCTION OF SUPEROXIDE ION AND OXIDATION OF HYDROXIDE ION IN DIMETHYL SULFOXIDE. *Anal. Chem.*, 40, 83-6 (1968).
Chronopotentiometry, controlled potential coulometry, pH titrations, infrared spectrometry and gas chromatography were all used in the investigation. Electrochemical kinetic parameters and mechanisms are discussed.
40. V. N. Greenwood, B. P. Straughan, and Anne W. Wilson. BEHAVIOR OF TELLURIUM (IV) CHLORIDE, BROMIDE, AND IODIDE IN ORGANIC SOLVENTS AND THE STRUCTURES OF THE SPECIES PRESENT. *J. Chem. Soc. (A)*, (1968) 2209-12.
Solvents investigated include DMF, acetone, MeCN, EtOH, DMSO, benzene and toluene. Results indicate the probable formation of a trimer in benzene and toluene, while the $\text{L}_2\text{TeX}_4 + \text{X}^-$ (where L = solvent) species is present in the other solvents.
41. G. Gritzner and J. Selbin. STUDIES OF DIOXOURANIUM (V) IN DIMETHYLSULFOXIDE. *J. Inorg. Nucl. Chem.*, 30, 1799-1804 (1968).
Controlled potential electrolysis techniques were used to prepare UO_2^+ from dry DMSO solutions of UO_2^{++} . Polarographic and spectroscopic data for UO_2^+ are reported.
42. W. S. Harris. ELECTROCHEMICAL STUDIES IN CYCLIC ESTERS. (Ph.D. Thesis). UCRL-8381, July 1958, 77 pages.
Solubilities, conductivities and electrodeposition studies of many inorganic salts in ethylene carbonate, propylene carbonate, γ -butyrolactone and cyclopropanone are reported.
43. J. R. Holmes, D. Kivelson, and W. C. Drinkard. PROTON EXCHANGE RATES AND HYDROGEN-BONDING FOR WATER IN ORGANIC SOLVENTS.

J. Am. Chem. Soc., **84**, 4677-86 (1962).

NMR and IR techniques were used to study the behavior of water protons in seven organic solvents. Equilibrium constants, activation energies and reaction mechanisms are discussed.

44. Yu. I. Ignatov and N. A. Jzmailov. EXCHANGE OF IONS OF DIFFERENT VALENCE IN NON-AQUEOUS SOLVENTS. *Zh. Fiz. Khim.*, 2482-5 (1965) (Russ.).

H₂O, MeOH, EtOH and Me₂CO solvent effects were studied for the Cs⁺ exchange on Ca and Cd forms of ion exchange resins. In all media, higher sorption of Ca²⁺ was observed, with almost no desorption of Cs⁺ occurring in Me₂CO.

45. R. T. Iwamoto. SOLVENT EFFECTS ON THE ELECTRO-OXIDATION OF IODIDE ION. *Anal. Chem.*, **31**, 955 (1959).

Chronopotentiograms taken at a platinum foil electrode indicate that iodide ion is oxidized in a one step process in water, MeOH, 1-BuOH, 2-PrOH and acetic acid. Two step reactions were observed in nine other solvent systems.

46. K. F. Jahr and J. Fuchs. A NEW METHOD FOR DETERMINING MOISTURE IN ORGANIC SOLUTIONS. *Z. Naturforsch.*, **14b**, 471-2 (1959).

Water can be determined in hydrocarbons, alkyl halides, ketones, esters and certain alcohols by titration of the (NH₄)₄V₄O₁₂ formed when (C₄H₉)₃VO₄ in benzene and an equal volume of CHCl₃ saturated with NH₃ are added to the solvent.

47. G. Jander and G. Winkler. ACETAMIDE AS AN IONIZING SOLVENT. I. CONDUCTOMETRIC TITRATIONS IN MOLTEN ACETAMIDE. *J. Inorg. Nucl. Chem.*, **9**, 24-31 (1959) (Ger.).

Molten acetamide was used to dissolve several inorganic and organic compounds and to prepare stable solvates. Acid-base neutralizations were performed both potentiometrically and with indicators.

II. ELECTROMOTIVE FORCE MEASUREMENTS AND POTENTIOMETRIC TITRATIONS IN MOLTEN ACETAMIDE. *Ibid*, 32-8.

The H⁺CH₃CONH⁻ dissociation product was confirmed potentiometrically and the K_d was determined as 3.2 × 10⁻¹¹.

III. WEEK AND STRONG ELECTROLYTES IN MOLTEN ACETAMIDE. *Ibid*, 39-44.

Equivalent conductivity measurements indicate complete dissociation of many inorganic salts and several acids. Thermodynamic dissociation constants for some acids were calculated.

48. G. Jander and H. Surawski. ACETIC ACID AS A NONAQUEOUS IONIZING SOLVENT. II. CONDUCTOMETRIC AND PREPARATIVE INVESTIGATIONS IN ACETIC ACID-FREE ACETIC ANHYDRIDE. *Z. Electrochem.*, **65**, 469-75 (1961).

AcClO₄ dissociates readily in Ac₂O, with probable solvation of Ac⁺ giving an orange-to-blood-red color.

III. POTENTIOMETRIC TITRATION OF ACETIC ANHYDRIDE FREE OF ACETIC ACID, AND CALCULATION OF THE ION PRODUCT ON THE BASIS OF POTENTIAL MEASUREMENTS. *Ibid*, 527-30 (1961).

A gold electrode was used to determine P = 3 × 10⁻¹⁵.

49. R. Jasinski. BIBLIOGRAPHY ON THE USES OF PROPYLENE CARBONATE IN HIGH ENERGY, DENSITY BATTERIES. *J. Electroanal. Chem.*, **15**, 89-91 (1967).

This bibliography lists some 42 reports on results of power supply investigations carried out under government contracts.

50. R. Jasinski and Susan Carroll. SPECTROPHOTOMETRIC DETERMINATION OF TRACE WATER IN PROPYLENE CARBONATE-LITHIUM PERCHLORATE SYSTEMS. *Anal. Chem.*, **40**, 1908-9 (1968).

Differential spectrophotometry, at 1.9μ, can be used to determine 20 parts per million H₂O in propylene carbonate and LiClO₄-PC solutions.

51. R. Jasinski and Susan Kirkland. ANALYSIS AND DISTILLATION ON PROPYLENE CARBONATE. *Anal. Chem.*, **39**, 1663-5 (1967).

Distillations were carried out in Podbielniak vacuum distillation column at reduced pressure, with analysis by gas chromatography and flame ionization.

52. B. Jeszwska-Irziebiatowska and M. Chmielowska. BEHAVIOR AND STRUCTURE OF URANYL NITRATE IN ORGANIC SOLVENTS. I. STUDIES OF URANYL NITRATE HEXAHYDRATE

- ORGANIC SOLUTIONS BY THE CONDUCTIVITY METHOD. *J. Inorg. and Nucl. Chem.*, 20, 106-16 (1961).
Dissociation constants are calculated from measurements made on $\text{UO}_2(\text{NO}_3)_2$ in 10 organic solvent systems. Gikerson dissociation constants and Bjerrum parameters are used to discuss solvation modes.
53. A. J. Johnson and L. L. Shrier. THE ANODIC BEHAVIOR OF U, Ti, Zr, Nb AND Ta IN 3M AlCl_3 -DIETHYL ETHER SOLUTION. *Corrosion Science*, 5, 269-78 (1965).
Nonaqueous AlCl_3 -ether solutions were used to prepare current-voltage curves with the appropriate metal as an anode.
 54. E. L. Johnson, K. H. Pool, and R. E. Hamm. EFFECT OF SEVERAL METAL IONS UPON POLAROGRAPHIC REDUCTION OF OXYGEN IN DIMETHYL SULFOXIDE. *Anal. Chem.*, 39, 888-91 (1967).
An unusual wave found on polarograms of Zn^{2+} , Sr^{2+} , Ti^+ , Y^{3+} and Cd^{2+} solutions in DMSO with oxygen is attributed to the formation of the metal superoxide.
 55. E. L. Johnson, K. H. Pool, and R. E. Hamm. POLAROGRAPHIC REDUCTION OF OXYGEN IN DIMETHYL SULFOXIDE. *Anal. Chem.*, 38, 183-5 (1966).
Two-wave polarograms indicate that oxygen undergoes a two-step reduction in DMSO.
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Carrier electrolytes for DMSO are examined, and the behavior of oxygen, magnesium and cadmium are illustrated and discussed.
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 $E^\circ_{\text{Cu(I), Cu(Hg)}} = +0.145 \text{ V.}$
 $E^\circ_{\text{Cu(I), Cu}} = +0.135 \text{ V.}$
 Ethanol: $E^\circ_{\text{Cu(II), Cu(I)}} = +0.340 \text{ V.}$
 $E^\circ_{\text{Cu(I), Cu(Hg)}} = +0.235 \text{ V.}$
 $E^\circ_{\text{Cu(I), Cu}} = +0.265 \text{ V.}$
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HMPT is one of the newer nonaqueous aprotic polar solvents with potential applications in all areas where this type of solvent is of value.

SUBJECT INDEX

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