



The
PUGET SOUND CHEMIST

Bulletin of the Puget Sound Section of the American Chemical Society

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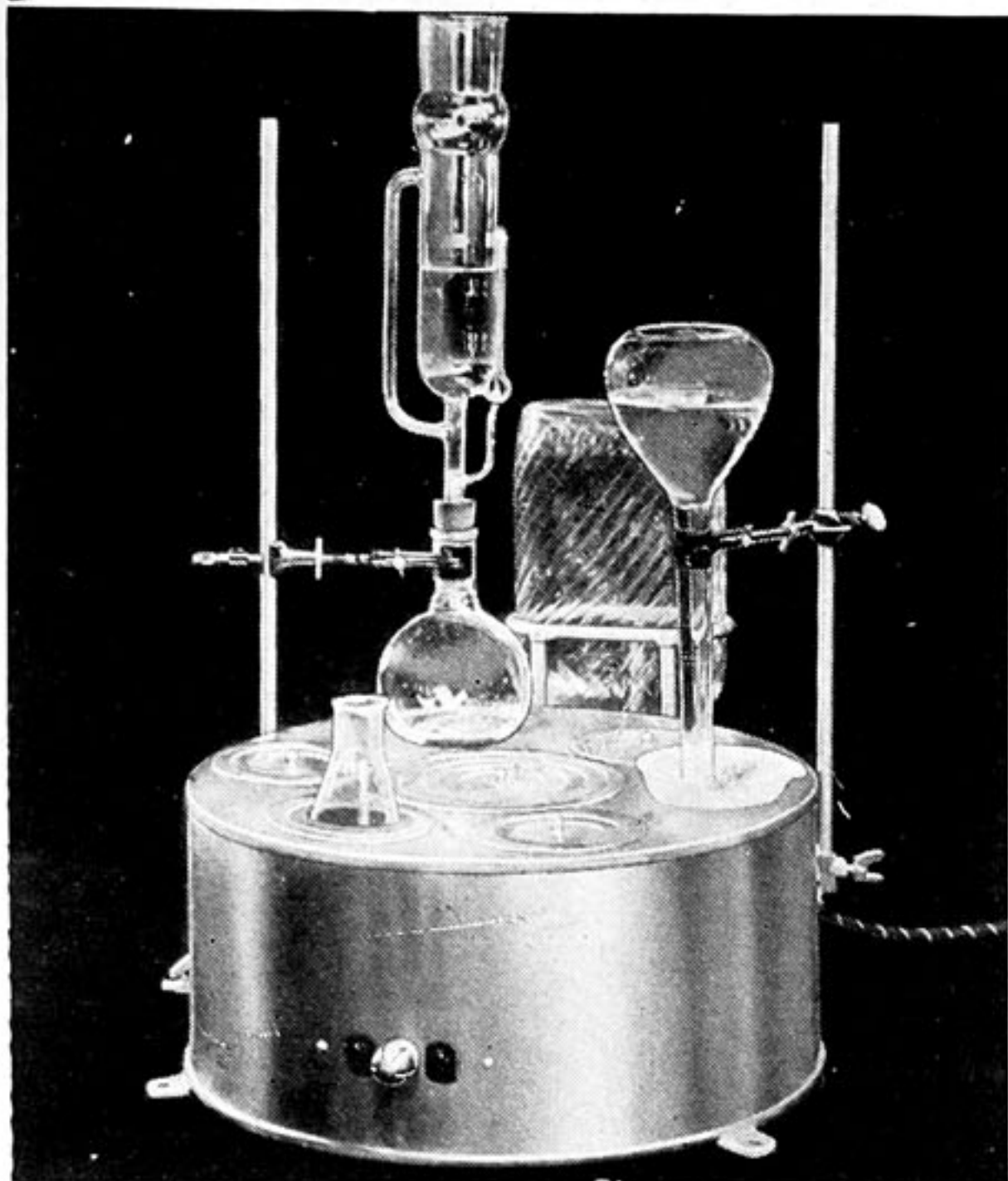
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May Meeting

**PUGET SOUND SECTION OF THE
AMERICAN CHEMICAL SOCIETY**

Tuesday • May 20, 1947

7:30 P.M.

Address • Bagley Hall • Room 140



Panel Discussion on

"The Professional Status of the Chemist"

ROGER HARRISON

W. R. MOFFITT

WALTER GAILEY

Q. P. PENISTON



**REFRESHMENTS AND SOCIAL HOUR IMMEDIATELY FOLLOWING
THE MAIN ADDRESS**

Chairman's Message . . .

RAMBLING OBSERVATIONS ON THIS AND THAT

Recession is a word that may well send shivers down the spine of the average person—however, thus far this year our growth of membership has shown no signs of such a tendency. In fact, our latest count shows that we now have 353 members actually enrolled and an additional 11 applicants now up for approval. This makes a total probable membership of 364, which is indeed a respectable figure, both numerically and in the quality of the membership represented.

★ ★ ★

Are chemists sociable? I heard an interesting comment on that at a dinner a short time ago. It was my privilege to be seated next to the wife of a chemist who happened to be research director of one of the larger corporations of this country. She made the observation that chemists and their wives were the easiest people on earth to entertain in her home. She reports that after the dinner or other preliminary activity the chemists congregate in one room and immediately resume their learned discussions in the field of chemistry while the women folk discreetly retire to another room where they just—talk.

★ ★ ★

Speaking of sociability of chemists, our little light refreshment-social hour immediately after our regular meeting programs seems to be functioning very well. Much favorable comment has been received on this aspect of our meetings and it furnishes a delightful opportunity to visit with the speaker of the evening as well as to greet your fellow members.

★ ★ ★

Our recent regional meeting is covered elsewhere in this issue. It was a well-attended and extremely successful meeting. Those who passed it up missed an interesting affair as well as a drive through an attractive part of the country at an extremely pretty time of the year. The weather was ideal throughout the

meeting, the papers were interesting, the food was good, and one of our main speakers even managed to discuss apple pie at length in his address!

★ ★ ★

Your Puget Sound Section officers and committee members have thus far spent a busy and, we hope, productive several months. In the first four months of this year the executive committee has met five times with a good attendance. Most of the committees and activities are functioning very effectively. Our program chairman, Dave Ritter, is doing a good piece of work. Several members are doing a much needed piece of work in bringing our membership information up-to-date under the direction of our secretary, Collis Bryan. A summer picnic is being planned. We have under way a study of the desirability of incorporating the section. This is being done under the supervision of John Meiler. Our magazine continues to maintain its previous high standards under the able supervision of Editor Orth. Our well laid plans for securing a national meeting in the fall of 1948 were knocked awry by the recent actions of the Council in eliminating a national meeting at that time—the future course of these national meetings still seems to be rather vague and we are awaiting information which will clear up the matter. Space does not permit me to mention by name all the various members who have made valuable contributions to the work of our Society during these past few months.

★ ★ ★

Are you an "out of this world" chemist? Many times we chemists have been accused of failure to participate effectively in the everyday workings of the society in which we live. That is a large issue that I will not attempt to discuss further at this time. However, I do feel impelled to appeal to that overly large portion of our membership who have not yet returned their questionnaire cards to our section secretary to do so at once. It is

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NORTHWEST REGIONAL MEETING AMERICAN CHEMICAL SOCIETY MOSCOW-PULLMAN MAY 2 and 3, 1947

***Sponsored by Oregon, Puget Sound, and Washington-Idaho
Border Sections of American Chemical Society***

Jamming Moscow and Pullman hotels to capacity, a crowd of 238 pronounced the 2nd annual Northwest Regional Meeting a distinct success. Perfect weather, enthusiastic hosts, and an excellent set of papers combined to make a perfect weekend.

Of the above number, 39 came from Puget Sound Section, 33 from the Oregon Section, 5 each from Montana and British Columbia, about 10 from the Hanford Engineering Works, and 126 from the Washington-Idaho border Section. 84 students and 19 non-members were also present.

The opening session was held Friday afternoon, May 2nd, in Science Hall at the University of Idaho. Chairman Harry L. Cole, Associate Professor of Chemistry at Washington State College, welcomed everyone on behalf of the Washington-Idaho Border Section. An address was made by Professor John C. Bailar, Jr., of the University of Illinois, on "The Formal Training of Chemists," after which a panel discussion was held. Professor Bailar expressed — "I feel strongly that our students need more non-science training, specifically in such subjects as English, Speech and Economics. They need, of course, instruction in the basic branches of chemistry and should have a little training in research methods. Whether all of these things can be included in a four year program is ques-

tionable. If they cannot, then the curriculum will have to be expanded. Chemistry cannot become a profession unless the members of the profession are really professional men."

Those participating in the panel discussion were: W. S. Anderson, President of Whitman College, Walla Walla, Washington, a former consulting chemist and teacher of chemistry; Dr. R. E. Curtis, from G. E. Nucleonics Project, Hanford Engineering Works, Richland, Washington; Joseph Schulein, Dept. of Chemical Engineering, Oregon State College, Corvallis, Oregon; Dr. H. V. Tartar, Professor of Chemistry, University of Washington, Seattle, Washington; and H. R. Erichson, Chairman of the Puget Sound Section, now with the Tower Company, Seattle, Washington.

After an afternoon of papers, a steak dinner was held at the Moscow Hotel and a capacity crowd of 129 was present. The speaker of the evening was Dr. Ralph H. Manley, Director of Research for General Mills. His talk, entitled "Current Trends in Industrial Research," emphasized the increasing tempo of industrial research and the "Symbiosis" of science and industry.

Saturday morning was devoted to papers at Washington State College, a total of 54 papers being given in the two days. At a luncheon, held in the dining room

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PRINCIPLES OF Electroplating and Electroforming

By **CHARLES V. SMITH**

Northwest Laboratories, Seattle, Washington

Electroplating is the coating of an object with a thin layer of some metal through electrolytic deposition to afford protection against corrosion or wear, to enhance beauty, to increase dimensions, or for a combination of these properties. Electroforming in general depends upon the preparation of a mold, deposition of metals on the mold, removal of the deposit and finishing the product. In both operations, the underlying principles and many of the techniques go hand in hand, and it is sometimes difficult to draw a sharp line of demarkation between them. Applications of electroplating and its twin, electroforming, reach into many phases of man's life from sentimentally preserving baby's first pair of shoes to the tough job of guiding a high speed shell down a gun barrel in deliberately planned destruction. Their commercial significance is indicated by the \$1,000,000,000 volume of business reported for the year 1945.

Electrodeposition of metals was introduced as an art during the first century by Egyptian alchemists who utilized the natural electromotive force differences between metals as one basic principle. For certain applications, coloring of badges, etc., the same procedures are still used. The fundamental concepts of electricity and chemistry were enjoined at the beginning of the nineteenth century and electrochemistry was born after Gilbert had established order in certain electrical phenomena, and alchemy was graduating into a science. In the short span of forty years, the efforts of several workers built the foundation for electrochemistry and the branches of electroplating and electroforming commanded immediate commercial attention.

Perfection of the voltaic pile in about 1800 provided a controllable source of electric current. Wollaston in 1801 made his famous observation that silver connected to a more positive metal such as zinc became coated with copper if put in a copper solution. In 1805 Brugnatelli discovered how to plate gold from a cyanide solution by connecting two pieces of silver metal to the negative terminal of a battery. In 1827 Ohm announced that voltage, resistance and current strength obeyed a fundamental law. In 1831 Faraday discovered the principle of an electric induction, and, in 1831, Pixii constructed the first generator. In 1833 Faraday demonstrated that quantities of metals reduced from chemical solutions by the effects of electric currents are not proportional to their chemical equivalents and the strength of the current. Jacoby, Spencer, and Jordan in 1838-39 each claimed priority to the art of reproduction of shapes of objects by electro-deposition (electroforming). In 1840 Boettger deposited nickel from a nitrate solution and immediately dropped this procedure in favor of the double salt, nickel and ammonium sulphate which resulted in a denser, more lustrous coating. In the same year DeRuolz successfully plated brass electrolytically from solutions of mixed salts of the brass metals. In 1844 Woolrych and in 1860 Pacinotti contributed greatly to the improvements of large generators required for the heavy currents.

The fundamental discoveries had thus been made and from here to 1900 the development came from practical men who exploited the field industrially. Progress was chiefly concerned with fabrication of larger generators and im-

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OUR COVER PHOTO

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"BLOSSOMS"

This month's cover entitled "Blossoms" is truly a tribute to the Northwest's long and beautiful Spring.

JUNE MEETING

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QUESTIONNAIRE . . .

At the January 15 meeting it was requested that questionnaire be sent to each member of the Puget Sound Section to get information that would assist in correcting mailing address errors and in compiling more accurate information of our members.

We have to date only received about 60% of the cards. If you are still carrying the card in your pocket, or are reluctant to send it in for some other reason, please contact Collis Bryan, our Secretary, and he will send you a shiny new one.

To have an accurate up-to-date file of our membership, all parts of the questionnaire should be filled out. If you are unemployed or have some other embarrassment, leave those sections blank, if you prefer—but send in the card!

Library Committee Activity

Miss Waller, Technology Librarian of the Seattle Public Library, has been interviewed by L. H. Brown of our Library Committee. She expressed interest in comments or suggestions from the ACS. The chemical library is continually expanding, and the ACS represents a large proportion of its users. Members are urged to communicate their ideas, particularly as to new books desired, to the Library Committee.

EMPLOYMENT—Chemist, 25 years broad industrial experience, seeks Northwest connection. Experience and qualifications listed with J. T. Stephan, Chairman, Employment Committee. James Greek, 21736 Snow, Dearborn, Michigan. Would come West for interview if prospects favorable.

NOTICE: *To those who wish to obtain the Bulletin of the Puget Sound Technical Society—please contact Richard P. Erwin, 2105 Park Road, Seattle 5, Washington, or Frank West at the University of Washington.*

MAY MEETING . . .

A heavy demand for a panel discussion on the professional status of chemists has prompted our May meeting. The professional status of the chemist today is an important problem which all chemists of the Puget Sound Section should be interested in. Our future as chemists will be definitely affected by the decisions we are going to be forced to make in the very near future. The chemist must uphold his society to preserve the inherent rights of the chemist to a profession which should be recognized publicly. The May meeting has therefore been devoted to a panel discussion on the Professional Status of the Chemist. The principals will be William Moffit of Casein Company of America, Roger Harrison of the Lyle Branchflower Company, Walter Gailey of Crescent Manufacturing Company and Q. P. Peniston, Pulp Mills Research Project, University of Washington.

This is a meeting you should be truly interested in attending. We would like to quote "In Union there is Strength," but do we want to be Unionized?

News Brief . . .

The editor has heard it rumored that Dick Erwin, formerly with Preservative Paint Company, is now working for the Grossman Paint Manufacturing Company, East 1118 Sprague Avenue, Spokane, Wash.

Tappi and Superintendents To Meet . . .

A joint meeting of the Pacific Coast Section of Tappi and the Pacific Coast Division of the American Pulp and Paper Mills Superintendents Association will be held at Gearhart Hotel, at Gearhart, Oregon, on May 22, 23, and 24. Technical papers will be given Friday morning and afternoon and Saturday morning. The social section will consist of a buffet supper and dance on Friday night and a dinner dance on Saturday night. Saturday afternoon will be devoted to golf.

HAL WILLIAMS IS WITH GENERAL PETROLEUM

A. E. Horn, Jr., Washington division manager, General Petroleum Corporation, announced today the appointment of Hal B. Williams as Process Products Engineer in charge of sales of specialized petroleum products for industrial use in the Washington division. Mr. Williams was graduated from the University of Washington in 1935. For the next five years he was engaged in graduate work in Chemistry at the University.

Mr. Williams had specialized in wood chemistry prior to joining General Petroleum. He was formerly chief chemist for the Seattle Charcoal Division of Crown-Zellerbach Corporation while that firm was engaged in war research and development for the U. S. Army's Chemical Warfare Service. He also served as process engineer for the Weyerhaeuser Timber Co. in Longview, Washington, and later filled a similar position with the Plywood Research Foundation in Tacoma.

With his new headquarters in Seattle, Mr. Williams has recently moved to that city from Tacoma.

CHAIRMAN'S MESSAGE . . .

(Continued from page 6)

true that this card involves only such mundane affairs as a correct address, a phone number, correct spelling of your name, etc., but we feel that it should be taken care of without further delay. Don't be an "out of this world" chemist.

★ ★ ★

Orchids to Boyden Bussard and Vic Sivertz for the swell job they did on arranging transportation and program respectively for the recent regional meeting.

★ ★ ★

We chemists make fervent declarations of our "professionalism" and lament the fact that we do not always have that high esteem in the eyes of the world. Are we, as individual chemists, even going through the motions of attaining and maintaining that honorable distinction of being truly professional? For ex-

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Solid Solution Formation In Mixed Selenate Sulfate Systems

CLAUDE E. THURSTON and G. B. KING

Abstract: Since selenate and sulfate ions are so similar in their physical constants, solid solubility is to be expected in pairs of salts whose cations have nearly the same physical properties. With this viewpoint in mind, solubility relationships in the following systems were investigated at 25 degrees:

Magnesium selenate—magnesium sulfate—water
Ammonium selenate—ammonium sulfate—water
Ammonium selenate—potassium selenate—water

Complexes of known composition were prepared and thermostated in the usual way. After reaching equilibrium, weighed portions of the solution and the residue were dissolved and diluted to 100 mls. volumetrically. Aliquots of these solutions were analyzed by standard methods giving compositions over the full range of solubility. The data were plotted on both triangular and rectangular graphs. The results show the presence of limited solid solubility over the full ranges of concentration for all of the systems studied. The solid solutions all belong to the conjugate type with one invariant point each, whose limits are readily explained on the basis of a difference in physical constants.

The Kinetics of the Oxidation of Hydroquinone by Peroxydisulfate

W. R. DAVIS and W. H. CONE

Abstract: The kinetics of the oxidation of hydroquinone with peroxydisulfate. The initial part of the reaction is essentially of the second order type with the rate being inversely proportional to the hydrogen ion concentration:

$$\frac{dx}{dt} = K_1 \frac{(a-x)(b-x)}{H^+}$$

During this initial period the hydrogen ion concentration is directly proportional

to the amount of the hydroquinone which has been oxidized:

$$\frac{dx}{dt} = K_1 \frac{(a-x)(b-x)}{K_2(x)} = K \frac{(a-x)(b-x)}{(x)}$$

$$Kt = \frac{1}{b-a} [b \ln(b-x) - A \ln(a-x)] + C$$

After this initial period the hydrogen ion concentration is no longer directly proportional to the amount of hydroquinone oxidized.

Magnetic Properties of the Iron Spinels

ALLEN B. SCOTT

Dept. of Chemistry, Oregon State College

I. Introduction:

Compounds having the general formula MOM'_2O_3 , or $M(M'O_2)_2$, where M and M' represent a bi- and trivalent metal respectively are found to have the lattice characteristics of spinel, $Mg(AIO_2)_2$, and are thus frequently called spinels. When M' is a transitional element of the fourth period (Fe, Co, Ni, or even Cr) and M is virtually any basic bivalent metal (Fe, Ca, Cu, Pb, etc.) the compounds are all more or less ferromagnetic. The best known example is $Fe(FeO_2)_3$, or magnetic oxide of iron. The purpose of this paper is to discuss the preparation and a few of the magnetic properties of certain of the iron-containing spinels, or ferrites.

II. Preparation of Ferrites:

A. *Wet way:* Upon making strongly basic a solution containing the desired bi- and trivalent ions in certain experimentally determined proportions, the ferrites are precipitated.

B. *Dry way:* If the desired oxides are mixed in equimolar proportions and strongly heated, the ferrites are produced. The temperature at which the reaction begins varies but is generally in the neighborhood of 600° C.

III. Magnetic Properties:

A. Ferrites prepared in the wet way, with the exception of Fe_3O_4 , are quite translucent and non-magnetic until

(Continued on page 21)

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Principles of Electroplating

(Continued from page 8)

proving plant layout. Rule of thumb no longer controlled the industry. Competition and demand for better electro-deposition of metals turned the race toward academic interests again in 1917 and since then there has been more and more research which has led to successful deposition of many metals, bright deposits with attendant reduction in buffing, the development of a commercial chromium plating process, and many details for improved techniques and quality. Today we find coatings scientifically applied with the thickness of each layer and the order of application work out to optimum conditions of protection, beauty, and cost. Continuous processes and speed of deposition has been increased through the efforts of both electrochemists and plater.

I. Plating Solutions

Three fairly definite types of aqueous solutions are used in electroplating and

are commonly designated as acid, neutral, and alkaline baths. These types may be roughly defined in terms of pH as being respectively: lower than 2, between 2 and 8, higher than 8. Examples of these three types are acid copper baths, nickel baths and cyanide baths. In spite of great progress in the study of dilute solutions, illustrated by the development and extension of the Debye-Huckel theory, there is still no adequate theory of the constitution of the concentrated solutions (frequently from 1 to 4M) that are commonly used in plating. Until a clear understanding is reached regarding the constitution of the plating solutions, it is difficult to explain the mechanism by which metal deposition occurs. The complexity of this problem and the difficulty of satisfactorily solving it may be illustrated by consideration of the fact that, although cyanide plating baths have been extensively used for about one hundred years, their constitution is not well established, and there is no general agreement regarding the mechanism of metal

deposition. The same is true for chromic acid solutions introduced in 1926.

So-called "addition agents" are used in many plating solutions of all types, but their functions and effects are not understood, and their selection is still entirely empirical. The use of addition agents has assumed new importance with the development in recent years of solutions as bright nickel plating, where their application eliminates or greatly reduces the buffing of the nickel plate prior to chromium plating. This new procedure not only saves the cost of buffing, but also conserves nickel.

II. Distribution of Current and Metal

Except with a few simple geometrical shapes and systems, current distribution over the electrode surfaces is not uniform and, therefore, deposition of the metal is non-uniform. Some baths have poor throwing power (inability to plate on shielded areas). Coupled with this is electrode polarization and bath efficiencies which can be additive for either negative or positive results. However, by balanc-

ing one factor against the other for a given solution, metals with certain desirable properties can be deposited over a wide range of current densities. In commercial work where many shapes must be plated, the attainment of optimum conditions remains an art which comes with years of experience and all technical assistance thrown in to boot.

III. Maintenance of Baths

An "ideal" plating bath having soluble anodes with anode and cathode efficiencies of one hundred per cent, might be expected to remain constant in composition. Baths having insoluble anodes such as those used in chromium plating are expected to deplete as metal is deposited. Actually all bath compositions change and can be kept uniform only by analyses and additions. Change in composition may arise from (a) loss of all the constituents in proportion to their concentrations in the bath, as a result of "dragout" of solution; (b) loss (or gain) in the content of metal (or other

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Principles of Electroplating

(Continued from page 15)

constituents) as a result of a difference in anode and cathode efficiency; (c) introduction of dissolved impurities from the anodes, cathodes, added salts or water, racks or dust; and (d) introduction of suspended impurities derived directly or indirectly from the same sources.

Bath agitation in plating not only serves to keep the bath uniform, but permits higher current densities to be used with a given bath concentration. The principal effect at the cathode is to replenish the concentration of dissolved metal at the electrode surface by reducing the thickness of the cathode film through which the metal salts or ions finally pass to the cathode. This is assisted by agitation. Agitation by air is unsuitable for cyanide baths, which are decomposed by the CO_2 present; or for ferrous salt baths, which are oxidized. Purification and filtration of baths are required for most baths in order to compete in modern day plating quality.

The large scale application of high current densities in bright nickel baths, chromic acid baths and copper cyanide baths has depended upon the use of solutions at temperatures from 40° to 60° C., preferably controlled automatically. Since bath temperatures may be as critical as current density or bath concentration, quality of modern plate depends upon accurate control.

IV. Materials of Construction

The development of chromium baths and the closer control of most plating baths have led to a more critical selection of the materials for constructing tanks and equipment. Wood is used for rinse tanks, steel for cleaners and alkaline solutions and lead-lined tanks for baths containing sulfuric or chromic acid. The most radical change has been the use of rubber-lined tanks for acid and neutral baths. The rubber linings are usually applied to steel tanks, either in the form of sheets of rubber (hard or soft) attached by appropriate cements,

or are sprayed on to produce seamless coatings. Another important class of materials developed in recent years includes the various stop-offs applied to insulate portions of work or plating racks. The need of relatively large currents at low but closely controlled voltages has limited the manufacture of motor generator sets for this industry to those who specialize in this field. The installation of large automatic conveyor systems in the hardware and automotive industries has created a demand for generators with outputs of 5,000 to 25,000 amperes, usually at six to twelve volts. By far the largest part of the current used in plating is now obtained from motor generator sets. However, within the last decade, several types of stationary rectifiers have been developed with capacities from one thousand to ten thousand amperes.

V. Testing and Control of Solutions

It is unwise to try meeting specifications for thickness and quality of coatings without checking the bath composition periodically, and such control is fairly simple. Analyses are required because of the following considerations: most plating baths in which soluble anodes are used tend to keep a uniform composition and relatively slow changes occur, such as may be caused by (a) differences in anode and cathode efficiencies or (b) dragout. It is usually necessary to control only a few major constituents, for example, the metal content and any significant anion, such as the chloride in a nickel bath, or the free cyanide in a cyanide bath. It is not usually practicable or necessary to control the concentration of any one constituent to closer than five per cent.

Frequent determination of some property such as pH may indicate the existence of conditions that cause unfavorable changes in concentrations or other constituents, and thereby lead to the correction of those conditions. Volumetric methods that are rapid, reliable and simple enough to be applied by persons with only elementary chemical training are now available for most of

the determinations. Colorimetric methods are simple and inexpensive for making approximate pH measurements which are based upon the fact that the colors of certain organic compounds (indicators) in solution depend upon the pH of the solution. Visual colorimetric measurements usually are not accurate to better than 0.1 to 0.2 pH. It is difficult to apply the method to highly colored or turbid solutions and to solutions containing active oxidizing or reducing agents. pH values may also be determined directly from suitable voltage measurements using the standard pH meters.

In recent years measurement and control of surface tension has been suggested in connection with alkaline cleaning solutions, pickling solutions, and plating baths, especially for bright nickel. The three common methods of measuring surface tension depends respectively upon the rise of the liquid in a capillary tube, the size of the drop that falls from the horizontal annular surface, and the pull required to detach a circular ring or wire from the liquid surface. Of these methods, the last two are most conveniently applied to cleaning or plating baths. The wetting agents used usually are salts of organic sulfonic acids.

VI. Properties of Deposits

Variation in Brinell hardness of electrodeposited metals varies from a value of 8 or 9 for tin, with zinc 45, cadmium 12 to 50, silver 60 to 125, copper 40 to 300, iron 145 to 250, nickel 125 to 500, cobalt 165 to 400 and chromium 400 to 1100, depending on plating conditions, namely current density, temperature, nature of solution and presence of various anions, cations, additional agents or foreign metals. Thickness of coat and hardness of base metal on which the plate rests complicates technique of determining true values. Smaller grain size and strain accompanies harder deposits. Tensile strength of electrodeposits of a relatively soft metal like copper, having tensile strengths from 12,000 to 50,000 pounds per square inch and elongations

(Continued on page 18)

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Principles of Electroplating

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from five to thirty-five per cent. For iron and nickel, the corresponding ranges are about 20,000 to 100,000 pounds per square inch and two to twenty per cent elongation. Ductility is reduced by included hydrogen which can be driven off by heat. Hydrogen does not effect hardness as was once suspected. Deposit thickness is of importance to insure maximum protection at lowest cost. Measurement is made by microscope on cross-sections, chord method on curved surfaces, timed chemical reactions and magnetic means. The adhesion of a plated coating is considered poor if the coating is detached when a stress is applied by deformation, change in temperature, evolution of gases or corrosion of the basic metal through pores. Poor adhesion is likely to result from (a) presence of some foreign material between the coating and the basic metal, usually faulty cleaning, (b) strains in the deposited metal, (c) a weak layer of metal on the surface of the basic metal or in the initial deposit. In tests, if some of the basic metal adheres to the detached coating or vice-versa, it is evidence that adhesive force is equal to the strength of one or both members. Under some conditions a weak alloy can form at the interface of the plated and base metal which results in poor bond.

Electrodeposited metals are characterized in general by higher hardness, lower ductility, greater anisotropy and frequently finer grain size than metals prepared by normal metallurgical means. Grain sizes range from crystals large enough to be seen with the eye to minute crystallites of approximately fifty Angstrom units. Metals which deposit with relatively coarse structures from simple solutions are zinc, copper, lead, tin, cobalt, nickel, silver and cadmium. All of these with the exception of lead can be deposited from complex solutions or from solutions containing addition agents in crystalline forms so fine that they are unresolvable microscopically. Coatings may be one-phase metal de-

posits, metallic compounds, solid solution, or two or more separate phases. By variation of conditions, it is possible to deposit single metals in more than one phase, provided that they are capable of forming more than one phase. Bright plating results in part from fineness of grain. Brightness and reflecting power are important in some applications. For the visible spectrum, reflectivities of ninety-five per cent are obtained with silver and aluminum, seventy-two per cent rhodium, chromium sixty-six per cent, and nickel sixty-two per cent with chromium being high in the ultraviolet range. The protective value of the more noble metals such as copper, nickel and chromiums on steel depends principally upon the freedom from porosity of the coatings. Thin chromium in itself is not particularly good where resistance to corrosion is a problem because of its porosity and tendency toward fine cracks. Frequently chromium is applied on an undercoat of copper or nickel or both, where it furnishes wear and tarnish resistance and the undercoats furnish the corrosion protection. Freedom from porosity is determined by salt spray, ferroxyl and hot water tests. The low coefficient of friction of chromium on itself or steel (.12 to .16), together with the fact that it can be deposited in porous conditions for retaining oil, has made it useful as liners for engine cylinders, etc.

VII. Common Applications and Processes

Electroforming operations are (a) electrotyping, which is the preparation of printing plates by depositing copper on wax, lead or plastic molds with subsequent facings of nickel and chrome to increase plate life, (b) making of molds for printing paper currency, (c) molds made for manufacturing phonograph records and (d) production of metal powders. Electroplating applications are (a) chrome on industrial, household and automotive hardware, (b) plating of tin on sheet steel for cans and refrigerator parts, (c) zinc on steel (galvanizing), (d) tool surfacing with chromium to increase life or (e) salvaging of worn

tools, shafts, etc., by building up to original dimensions with nickel or chrome. Chromium surfaced molds for pressing plastic lenses have been developed that are free from defects under 500X magnification and which have perfect optical surfaces.

Following is a brief summary of satisfactory chromium plating conditions:

When current is passed through a solution containing only pure chromic acid and water, no chromium plate results. To convert such a solution into a plating bath, presence of acid radicals, such as sulphate, fluoride, etc., are required. The essential factor in bath composition is the ration of chromic acid (CrO_3) to the total catalyst acid radicals expressed as sulphate (SO_4). This ratio should be approximately $\frac{100}{1}$. Either anhydrous sodium sulphate (Na_2SO_4) or sulphuric acid (H_2SO_4) can be used. Since sulphate is present in varying amounts even in the purest chromic acid, allowance must be made for it, as well as other catalytic acid radical catalysts, when adjusting the composition of the bath.

A typical chromium bath composition is:

Chromic acid (CrO_3)—53 oz. per gal.

Sulphate (SO_4)—0.53 oz. per gal.

Trivalent chromium compounds and metallic impurities, such as iron, copper, and zinc, decrease the conductivity of the solution. When these impurities are permitted to build up in large quantities they may be objectionable.

The surface of the work to be plated should first be prepared so that it has the appearance desired for the finished plated surface, cleaned and then plated, for example, at a temperature of 125° F. and a current density of 400 amperes per square foot.

Insoluble tin-lead or antimony-lead anodes are used in chromium plating baths.

Cleaning before plating and the adherence of the deposit are especially important for good results both decorative or industrial (heavy) chromium plating. Aside from removing all grease, dirt,

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Principles of Electroplating

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rust and scale from the surface, good adherence is usually assured by a reverse current etch in 30% sulfuric acid or in a chromic acid solution as the final step in the cleaning process. The reverse current is applied for one-half to one minute with six volts, although shorter or longer times may be used.

Futures of Electroplating

Electroplating has arrived at an industrially important level. Its future has been insured by those who have already contributed. For those interested in electroplating as a future, there are many possibilities in both the academic and practical end. The ever-increasing amount of research being done by the expanding technical staffs of such groups as Udy-lite Corporation, United Chromium, International Nickel, Battelle Institute, Columbia University and others, will open new doors. In the practical or application field opportunities are excellent

for those business-minded individuals who will only gird themselves with modern technology.

ABSTRACTS . . .

(Continued from page 12)

heated. At higher temperatures, yet to be determined accurately, they become opaque and upon cooling are ferromagnetic. Studies are being made to ascertain whether this behavior can be totally attributed to loss of water of hydration, and as to whether the loss of translucence exactly accompanies the transition to a ferromagnetic material.

B. Ferrites made in the dry way are ferromagnetic upon cooling after preparation. The Curie points of most lie in the region 400-700-C. The effectiveness of mixed oxides as catalysts are discussed as a function of their magnetic properties.

C. An attempt is made to correlate existing theories of ferromagnetism with the structure and magnetic properties of ferrites.

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N. W. REGIONAL MEETING

(Continued from page 7)

of the Washington State College Home Economics Building, the guest of honor was President Wilson Compton of Washington State College, who spoke briefly. Two short of a capacity crowd of 150 attended.

In the afternoon a speech by Dr. I. Perlman of the University of California Radiation Laboratory on "The Preparation of the Transuranium Elements" drew a full turnout in spite of a competing WSC-OSC baseball game which started at exactly the same time on a nearby field. Dr. Perlman traced briefly the means by which the four known transuranium elements were discovered and the first separation in weighable amounts of the three elements that have to date been isolated. Particular emphasis was given to the most famous of the transuranium elements, plutonium, with a brief discussion of the development of the method by which it is separated in the Hanford Plant.

A social get-together held Saturday evening in the Washington State College Home Economics Building was attended by approximately 60. Entertainment was furnished by W.S.C. student members of the Collegiate Radio Guild. Refreshments were served.

The meetings were attended by Merritt L. Hastens, Associate Editor of Chemical and Engineering News, located in San Francisco.

At an executive Committee Meeting, an invitation from the Oregon Section for the next regional meeting was accepted.

CHAIRMAN'S MESSAGE . . .

(Continued from page 10)

ample, are we all reading at least some of our own technical journals? You will remember that during the war we all had swell excuses for neglecting this excellent but arduous portion of our professional responsibilities, but now our time is our own again. It is up to each of us individually to insure that we are not allowing this and other worthwhile activities to be crowded out of our "professional" lives.

ABSTRACTS . . .

(Continued from page 21)

Phase Rule Studies In the System Ammonium Nitrate and Ammonium Salts of Organic Aliphatic Acids

E. C. GILBERT

Chemistry Dept., Oregon State College

Abstract: A report of melting point composition studies conducted for the Committee on Eutectics of the National Research Council on mixtures of ammonium nitrate with six ammonium salts of aliphatic organic acids. Simple eutectics are reported in most instances.

The Refractive Indices of CIS and TRANS Decahydronaphthalene

M. STUSIAK and WM. F. SEYER

The refractive indices of cis and trans decahydronaphthalene for the C, D and F lines were measured between the temperatures of 10° and 90°C. It was found that the refractive index was linear with temperature over the range of temperature studied. The molecular refractive indices were also calculated.

Conversion Velocity of the CIS to the TRANS form of Decahydronaphthalene in the presence of Aluminum Chloride.

WM. F. SEYER and C. W. YIP

The velocities of conversion were measured at 0, 10, 25, 35 and 45°. Although the reactions were complex the "over-all" velocities could be represented by two first order equations. The one holding approximately for 0 to 90% transconcentration, the other from 90-100%.

Measurement of Strain Potentials In Salt Solutions

WM. F. SEYER and OSWALD MINIATO

Wires of copper and other metals have been stretched in several salt solutions and the potential between the stretched and unstretched wires measured. The measured values agree reasonably well with those calculated from thermodynamic principles.