

Technical Section

Development of Electrochemistry in the U.S.S.R.*

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INTRODUCTION

SINCE the war the interest in theoretical and applied electrochemistry has considerably grown. This is indicated by many conferences on the development of this science in the USSR, USA, Britain, GDR, Czechoslovakia, FRG, Italy, Poland, Canada and other countries held in recent years and the setting up of a special International Committee on Electrochemical Thermodynamics and Kinetics. The fact that the older electrotechnical magazines have been enlarged in size along with many new publications including articles and monographs, the number of which is growing every day, is also a pointer in this direction. The last few decades have been marked by great achievements in electrochemical kinetics which has grown into a separate section of physical chemistry, while in the earlier periods the main attention was drawn to the explanation of properties of electrolytic solutions and investigations of electrochemical systems in a state of equilibrium.

The electrode reactions involving the metal electrons on the one hand and solution ions or molecules on the other take place on the border between metals and electrolytic solutions. Therefore, a thorough investigation of this border has been greatly important for understanding of their mechanisms. On the other hand the electrochemical processes in which the joining and separation of electrons occur is a most important and interesting class of chemical reactions. Therefore, the development of problems of theoretical electrochemistry and use of electrochemical methods become more important for a solution to the main chemical problem—that is, elucidation of a chemical transformation mechanism and understanding of a phenomenon taking place in a solution and melt.

Modern theoretical electrochemistry has penetrated deep into the phenomena on the borders between the different media which form the basis of an electrochemical source of power, commercial electrolysis, corrosion of metals and electron

emission. The development of electrochemical kinetics and thermodynamics makes it possible to use theoretical electrochemistry widely in solving some problems of great practical importance.

Problem of Chemical Source of Power

First of all mention should be made of a problem of chemical source of power whose importance has now been extremely increased. Now it is needed by virtually all kinds of modern transport and other technical equipment. At the same time the technical development makes ever increasing demands of chemical sources of power, their specific capacity and energy, working temperature interval, and ability to remain quiet while changing over to greater loads. Use of atomic energy for transport should further extend the application of electrochemical sources of power accumulated. Creation of new, more powerful and cheap electrochemical sources of power could provide a good basis for a reasonable solution to such important problems of national economy as electrification of the urban transport and use of electricity in ploughing, and in the long run it could help in solving the problem of wind and solar energy accumulation. The importance of electrochemical sources of power for artificial earth satellites is obvious. Of great importance is creation of a more powerful and stable gas electrode on the basis of which there could be built a storage battery with use of a small quantity, if any, of non-ferrous metal.

In recent years some progress has been made in obtaining a hydrogen-oxygen chain. It can be considered as a first step towards a solution to the problem which for many years excited the electrochemists, that is, the production of a fuel element in which the chemical energy of a fuel could be immediately converted into the electrical energy. Chemical alterations and ionisation caused by radiation in the electrolytic solutions and on the border between the solutions and solid electrodes can be used to generate the electric current by

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atomic energy. Some kinds of such systems already exist. Further steps in this direction should be based on combination of radiational and electrochemical investigations.

New Applications of Electrolysis in Chemical Industry

The last few decades have seen new applications of electrolysis in chemical industry. Of these the most popular is the production of fluorine and its derivatives by electrolysis of deuterium. Technical use of electrical synthesis of organic combinations is still limited although it is very probable that the results achieved in a modern theory of electrical reduction will help in developing new methods of production of valuable organic combinations by means of electrolysis. Of special interest is use of electrolysis in production of raw materials for the plastic and synthetic fibre industries. Use of electrochemical methods in metallurgy is growing more and more. The electrochemist's attention is now focussed on the development of the electrochemical methods of production of such metals as titanium, zirconium, niobium, tantalum which become more and more important for engineering progress. Electrolysis is also very important for production of highly pure metals. A discovery of galvanoplasty made in 1837 by a Russian scientist Jackoby was the first step in a large scale practical application of electrochemistry. A classical section of technical electrochemistry, i.e. electrolytic plating, is still very important today, the requirements for quality of plating being various. Along with the decorative plating more extensive use is now being made of the one with certain mechanical corrosion resisting, optical, and magnetic properties. Sometimes, mechanical finishing of metals is successfully replaced by electrical polishing. It results in saving labour and adds to quality of goods.

The poorly investigated phenomena on the border between semi-conductors and electrolytic solutions deserve special attention. Such a border can have very important characteristics. The study of these characteristics will result in extending the use of semiconductors in modern engineering.

Problems facing Soviet Electrochemists

The Soviet electrochemists are also faced with the important problems related to the investiga-

tion of primary and secondary electronic emission and other processes associated with the existence of contact potentials on the border between metals or semiconductors on the one hand and vacuum on the other. Till recently these phenomena which are so important for radio engineering have been largely the matter of concern of physicists. It is obvious, however, that a joint use of results of the electrochemical investigations would have been most fruitful. Since the Great October Revolution the development of electrochemical engineering has made a very good progress in Russia. Today the USSR has developed a mass production of chlorine, alkali, oxidizers, non-ferrous and light metals, primary and secondary electrochemical sources of power which are produced at a high technical level. Extensively used are electroplating, metal treatment by electrical polishing, and electrochemical production of metals from corrosion. The research work in electrical chemistry has also been greatly intensified. The Soviet electrochemists have concentrated their attention on such questions as relationship between the electrochemical and absorptional phenomena, double electron layer theory, mechanism of a potential difference between the different phases, electrical precipitation of metals and growth of crystals on electrodes, local element theory, passiveness and so on. It should be said, however, that in view of the vast plans of the development of chemical industry and metallurgy this research work should be regarded as inadequate. Probably more than in many other sciences, in electrochemistry new technical achievements can be realised only on the basis of further development of theory and deep study of mechanisms of the processes. In this connection the USSR Academy of Sciences has made a decision to build in Moscow and Sverdlovsk two new electrochemical institutes. The activity of the Sverdlovsk Institute will be concentrated on the problems of high-temperature electrolysis.

These institutes are to be the centres from which the joint activity of Soviet electrochemists will be co-ordinated. They will also maintain and strengthen friendly scientific relations with the electrochemists from other countries. I hope, in particular, that we shall establish lasting contacts with the Indian electrochemists. I am sure that mutual exchange of experience will make a certain contribution to the development of this important science in both countries.