is subdued to what it works in, we feel, too, that that is an essential ingredient of his success, and that with less complete absorption his work might have been less brilliant as well as less convincing.

R. A. S.

ULTRAMICROSCOPIC STUDIES OF THE COLLOIDS.

Zur Erkenntniss der Kolloide. Ueber irreversible Hydrosole und Ultramikroskopie. By Richard Zsigmondy. Pp. vi+185. (Jena: Gustav Fischer, 1905.) Price 4 marks.

THIS work forms a valuable addition to the literature of the colloids, giving as it does an authoritative account of the results obtained through the application of the method of ultramicroscopy to the study of solutions of colloids.

A brief account is first given of the nature and properties of colloid solutions or hydrosols. At the outset the author refers to the difficulty of giving a satisfactory definition of the term "solution." He adopts homogeneity as the most universal characteristic of solutions. The definition of homogeneity will naturally vary according to the delicacy of the methods employed to test it. By means of the method of ultramicroscopy devised by Zsigmondy and Siedentopf, the majority of colloid and even some crystalloid solutions can be shown to be optically heterogeneous. Every increase in the accuracy of the methods of examination would lead to a further limitation of the term "solution." In order to include the colloids Zsigmondy defines solutions as uniform distributions of solids in fluids, which are transparent to ordinary light, and not separable into their constituents by the action of gravity or by filtration.

In order to gain a clearer idea of the nature of colloid solutions, it is necessary to find criteria for distinguishing such solutions from those of crystalloids on the one hand and from suspensions on the other. Zsigmondy only refers very briefly to the distinguishing characteristics of the former, as this subject has been previously treated by Bredig in his monograph on "Inorganic Ferments." He deals more fully with the properties of colloid solutions which distinguish them from suspensions. In this connection he mentions the following as the chief features distinguishing colloid solutions from suspensions:—

(1) The particles in colloid solutions are much smaller than in suspensions. In colloid solutions the average diameter of the particles varies from 5 to 20 $\mu\mu$. This difference is, however, one only of degree.

(2) Many colloids are capable of undergoing irreversible changes. Separation of a metal from its colloid solution may be readily brought about by the withdrawal of water or the addition of electrolytes. In this process the metal has undergone an irreversible alteration or coagulation. For the reformation of the colloid solution, chemical or electrical means must be employed. In the case of suspensions, on the other hand, sedimentation rapidly takes place under the influence of gravity, and its rate is little influenced by the withdrawal of water or by the addition of electrolytes. The suspension may be reformed by purely mechanical means.

(3) Alterations in the total energy of the system are frequently associated with the process of coagulation. These have been measured in several cases by means of the calorimeter.

(4) Colloids in solutions are capable of undergoing reactions with one another, which closely simulate purely chemical reactions.

The next section of the book deals with the classification of colloid solutions or hydrosols. The classifications of the hydrosols have been based on two principles, namely, the size of the particles and the reversibility or irreversibility of the hydrosol (Hardy). On plate i. the author gives a graphic representation of a classification of colloids founded on these principles. The reversible colloids differ from the irreversible in not being readily coagulated by the addition of electrolytes. It is noteworthy that irreversible colloids may be partially protected from the coagulating action of electrolytes by the addition of a reversible colloid to their solutions. Great quantitative differences are found to exist in the extent of protection given by different reversible organic colloids to irreversible gold hydrosols.

A historical account of the preparation and properties of irreversible colloid solutions occupies the next section of the book.

The author next gives an interesting account of the development of the method of ultramicroscopy by Siedentopf and himself. A full description is also given of the necessary apparatus and of the method of using it.

The succeeding sections give details of the results of his own researches on gold hydrosols. By means of the ultramicroscope he was enabled to determine approximately the average size of the gold particles, their colour, and the rapidity of their movements both translatory and oscillatory. The limit of size determinable by the ultramicroscope appears to be about 6 $\mu\mu$ in the case of gold hydrosols. Still smaller particles (amicrones) are also present in gold hydrosols. Their presence may be proved by the coagulation of the hydrosols on the addition of electrolytes.

An excellent summary is also given of the results obtained by other observers through examination of various colloid solutions by means of the ultramicroscope.

Brief reference only is made to some points of great theoretical interest, namely, the causes of the stability of colloid solutions, and the mechanism of their formation.

The book concludes with a short summary of what is known with regard to the products of coagulation of colloid solutions.

The work as a whole is to be regarded as a valuable monograph indispensable for those interested in the ultramicroscope and its applications.

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