cadmium by weight, and a triangular close-packed lattice of axial ratio 1.89, found in alloys of from 60 to 100% cadmium by weight.

The conflicting data on the crystal structure of mercury are discussed and it is suggested that the present work indirectly indicates a face-centered (or body-centered) tetragonal structure. It is pointed out that the frequent assumption of intermetallic compounds in this system receives no support from the present crystal structure data.

The isomorphism of cadmium and the face-centered tetragonal component (which may be mercury) is favored by similar atomic volumes and also by the presence in the face-centered tetragonal lattice of an atom arrangement closely approximating the unit hexagonal prism of cadmium both in lattice type and in the unit cell dimensions.

[CONTRIBUTION FROM THE KAISER WILHELM-INSTITUT FÜR PHYSIKALISCHE CHEMIE UND ELEKTROCHEMIE]

A NEW METHOD FOR THE STUDY OF CATAPHORETIC PROTEIN MOBILITY[1]

BY HAROLD A. ABRAMSON

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It has previously been shown[2] that the cataphoretic migration of inert particles suspended in gelatin gels represents the movements of the micellae of the gelatin. That is, there seemed to be a rapid formation of a sheath of the gel about the particle which changed its sign at the iso-electric point of the protein. The study of the migration of the particle, therefore, afforded a simple means of studying the cataphoresis of the gelatin micellae themselves. This has led to the study of the influence of proteins on the migration of quartz particles in sols of low concentration. A concentration of 1×10^{-7} already lowers ζ, the electrokinetic potential, appreciably. Between concentrations of about 1.10^{-5} and 1.10^{-4} g. per liter the maximum effect of the protein is reached and the particles behave like gelatin. Egg albumin shows a similar influence.

A suspension of quartz particles in a dilute solution of the proteins mentioned (within limits of dilution) gives the absolute electrophoretic migration of the protein micellae. The complete data and theory of these phenomena will be presented elsewhere.[3] Svedberg and Tiselius[4] have used a rather elaborate method to determine the mobility of egg albumin. It seemed that a comparison of their method with ours was of interest.

[1] The researches here reported were made in part during a tenure of a Medical Fellowship of the National Research Council.

[2] Freundlich and Abramson, *Z. physik. Chem.*, **128**, 25 (1927).

[3] *Z. physik. Chem.*, in press.

[4] Svedberg and Tiselius, THIS JOURNAL, **48**, 2272 (1926).

Method

The migration of the quartz particles was studied in a type of microelectrophoresis cell described elsewhere.[2] Fairly pure powdered egg albumin (Merck) is made up in $M/50$ acetate buffer solutions.[5] Concentrations of 1×10^3 g. per liter of egg albumin are preferred because at this concentration the correction for dielectric constant is probably negligible and the solutions are sufficiently concentrated to give maximum values of ζ. The quartz particles should be between 0.5 to 5.0μ, and 1.0 mm.[3] of the final solution should have between 10,000 to 100,000 particles. No attention need be paid to the shape or state of aggregation of the quartz particles as, contrary to the theoretical considerations of Debye and Hückel,[6,2] cataphoretic migration of quartz particles in water and aqueous solutions is independent of the form of the particle and of the state of aggregation. Consequently, measurements may be made from any particle. (An occasional particle shows a wide deviation from the mean which is unexplainable on the basis of its shape. Such values are discarded.) Although equilibrium seems to set in more quickly, fifteen minutes are allowed to elapse between the making of the suspension and the measurements.

Experimental

The data for egg albumin are presented here in order to compare our values with those of Svedberg and Tiselius for the same protein.[4] These authors used a 1.0% albumin solution. As the dielectric constant of a solution of this protein at this concentration is 72,[7] it follows from the Helmholtz-Lamb equation, $V = \zeta HD/4\pi\eta$, in which V = velocity of particle, ζ = electrokinetic potential, H = potential drop per cm., η = viscosity of the medium, all in C. G. S. electrostatic units, that the values observed by Svedberg and Tiselius in the more concentrated solution should be lower than those observed here. Further, the presence of a 1% protein solution may alter the ζ-potential itself (see Table II). This is actually the case. The data given in Table I, a typical experiment, have been

TABLE I

TYPICAL EXPERIMENT

P_H	μ/sec./volt, cm.	ζ-pot., mv.	P_H	μ/sec./volt, cm.	ζ-pot., mv.
3.4	+2.1	+27	4.8	Negative	Negative
3.9	1.6	21	5.0	−0.35	−4.5
4.2	0.83	11	5.3	.57	7
4.4	.55	7	5.55	− .68	−8
4.65	+ .30	+ 4			

[5] International Critical Tables, Vol. I, 84 (1926).

[6] Debye and Hückel, *Physik. Z.*, **25**, 49 (1924); Hückel, *ibid.*, **25**, 704 (1924).

[7] Fürth, *Ann. Physik*, **70**, 60 (1923).

obtained from a 1.10^{-3} g. per liter egg albumin solution. The ζ-potential has been calculated using the values given for water of D and η.

TABLE II

DATA RECALCULATED FROM SVEDBERG AND TISELIUS

P_H	μ/sec./volt, cm.	ζ-pot., mv.	P_H	μ/sec./volt, cm.	ζ-pot., mv.
3.4	+1.7	+22	5.0	0.40	5
3.96	0.92	12	5.25	.58	7.5
4.27	.31	4	5.36	.11	10
4.5	+ .16	+ 2	5.75	−1.0	−13
4.81	− .09	− 1.5			

In Fig. 1, Svedberg and Tiselius' data have been corrected for D, and have been also recalculated for 21°. The dots represent our data from three different experiments. The open circles are the recalculated figures

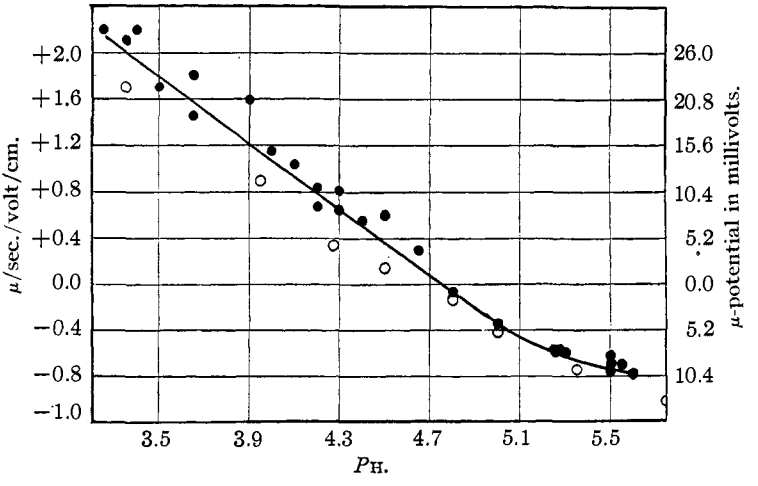

Fig. 1.—The dots indicate protein mobility found in the experiments described in this communication. The open circles are the recalculated data from Svedberg and Tiselius. The signs on the ordinate refer to the charge.

of Svedberg and Tiselius. This correction is 15% for the difference in temperatures and 11% for D. It is evident that the method presented here compares favorably with that of Svedberg and Tiselius. It is further obvious that it affords a most sensitive means of detecting proteins in extremely small quantities and presents a new means of studying their behavior. It also admits of a macroscopic variation.

It is a pleasure to thank Professor H. Freundlich for his continued guidance.

Summary

1. Quartz particles suspended in dilute protein solutions under certain

conditions move cataphoretically as if the migration were due to a surface consisting of the pure protein.

2. Based upon this adsorption of protein by quartz, a method for studying the mobility of protein is presented.

3. The results for egg albumin for a variable hydrogen-ion concentration agree satisfactorily with the values given by Svedberg and Tiselius.

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[CONTRIBUTION FROM THE SCHOOL OF CHEMISTRY, THE UNIVERSITY OF MINNESOTA]

THE DETECTION OF TRACES OF BERYLLIUM AND THE COLORIMETRIC DETERMINATION OF THIS ELEMENT

BY I. M. KOLTHOFF

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Recently[1] it has been shown that adsorption indicators can be used advantageously for the detection and colorimetric determination of some elements. In a solution weakly acid with acetic acid and acetate (P_H about 5.5) aluminum, for example, gives a very nice and sensitive color reaction with 1,2,5,8-oxyanthraquinone. For magnesium, we found titan yellow to be an excellent reagent.[2]

In investigations on the solubility of the slightly soluble metal hydroxides it is of great practical advantage to have color reactions at our disposal with which we can determine traces of dissolved oxides. For the determination of the solubility of beryllium hydroxide (which is extremely small at the isoelectric point) at different hydrogen-ion concentrations we wanted such a method. As is well known, there are only a very few characteristic reactions for beryllium, and only two color reactions have been described in the literature.[3] For this reason we tried to detect and determine it by means of adsorption indicators. The beryllium hydroxide is precipitated at the proper P_H in the presence of some useful indicator and the color of the solution or the lake formed is observed.

1,2,5,8-Oxyanthraquinone as Indicator[4] (0.1% solution in alcohol).—To 10 cc. of the solution, 0.1cc. indicator and 6 to 8 drops of 4 *N* ammonia

[1] Kolthoff, *Chem. Weekblad*, **24**, 447 (1927).

[2] Kolthoff, *ibid.*, **24**, 254 (1927).

[3] The aluminon (aurintricarboxylic acid), which forms a red lake with aluminum [Hammett and Sottery, THIS JOURNAL, **47**, 142 (1925); Lundell and Knowles, *Ind. Eng. Chem.*, **18**, 60 (1926)], is also suitable for the detection of beryllium [A. R. Middleton, THIS JOURNAL, **48**, 2125 (1926)]. According to the statements of Middleton, this reaction is not as sensitive as those described below in this paper.

[4] After writing this paper the author found that the reagent has been already applied by Hellmut Fischer, *Wissenschaftl. Veröffentl. Siemens Konzern*, **5**, 99 (1926); *Chem. Zent.*, **1927**, I, 495, who determined the dyestuff in the lake in a colorimetric way. As no details are given in the abstract referred to, the practical statements made above may be of some value.