Specific Conductivity of Aqueous Solutions of Sodium Salt of Poly-D-glutamic Acid under High Pressure

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In the present experiment, the specific conductivity of sodium salt of poly-D-glutamic acid (NaPGA, M. W. 8.3×10^4)¹⁾ in aqueous solutions (pH 8.5) at concentrations between 10.27×10^{-3} and 5.13×10^{-3} M) was measured at 30°C and up to 6.3×10^3 atm. The conductivity measurements were carried out in a Teflon cell,²⁾ fitted with platinum electrodes, which was mounted in a conventional steel pressure vessel.³⁾ The conductances of the solution were measured by a Yanagimoto MY-7 conductivity outfit (800 cps).

The experimental results are listed in Table 1. It may be seen that there is a maximum in the conductivity at a pressure of about 3.6×10^3 atm in each solution, no matter what the concentration of NaPGA. Such a result is common to the aqueous solutions of simple salts, such as potassium chloride,⁴,⁵⁾ and magnesium chloride,⁶⁾

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1) The sample was kindly donated by Dr. Junzo Noguchi, Hokkaido University.

2) J. C. Jamieson, *J. Chem. Phys.*, **21**, 1385 (1953).

3) K. Suzuki and Y. Miyosawa, Symposium of High Pressure (Japan Chem. Soc.), **5**, 15 (1963).

4) S. D. Hamann and W. Strauss, *Trans. Faraday Soc.*, **51**, 1684 (1955).

5) R. A. Horne, B. R. Myers, and G. R. Frysinger, *J. Chem. Phys.*, **39**, 2666 (1963).

6) R. A. Horne, W. J. Bannon, E. Sullivan, and G. R. Frysinger, *J. Electrochem. Soc.*, **110**, 1282 (1963).

TABLE 1. SPECIFIC CONDUCTIVITY (10^{-4} ohm^{-1} cm^{-1}) OF AQUEOUS SOLUTION OF NaPGA AT 30°C

Concn., 10^{-3} M	Pressure, atm							
	1	900	1800	2700	3600	4500	5400	6300
10.27	4.939	5.414	5.687	5.834	5.879	5.874	5.811	5.710
9.34	4.585	5.059	5.320	5.435	5.476	5.452	5.394	5.313
8.56	4.249	4.680	4.908	5.038	5.065	5.038	4.994	4.897
7.90	3.929	4.352	4.537	4.649	4.693	4.693	4.655	4.595
7.33	3.651	4.040	4.244	4.335	4.368	4.363	4.324	4.261
6.42	3.245	3.604	3.768	3.848	3.877	3.874	3.830	3.775
5.135	2.592	2.846	2.992	3.068	3.102	3.102	3.077	3.031

it has been well explained by the fact that the viscosity of water passes through a minimum at about 1.0×10^3 atm.⁷⁾ It seems that the present result can be explained by the same reason.

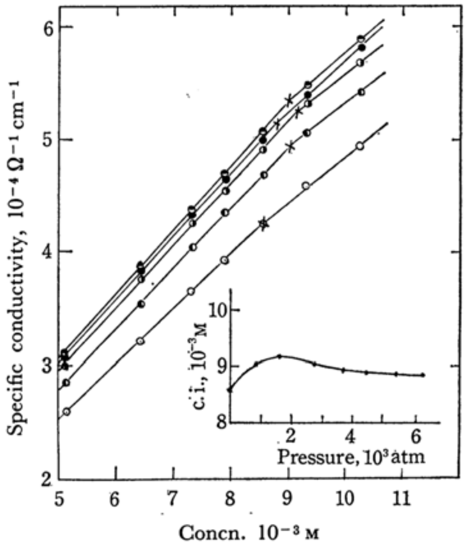

Fig. 1. The specific conductivity of NaPGA in aqueous solution at 30°C and at 1, 900, 1800, 3600, and 5400 atm. The sign, × denotes the intersection of both straight lines. Inset: The variation of the concentration at the intersection (c. i.) with pressure.

—◓—	3600 atm	—◐—	900 atm
—●—	5400 atm	—○—	1 atm
—◑—	1800 atm		

If the conductivity data are plotted against the concentration, the points lie on two straight lines with a different slope at each pressure, as Fig. 1 shows. Ascoli and Botré⁸⁾ found the same phenomena at 1 atm. The concentration at the intersection is called the c. i., which corresponds to the critical micell concentration (cmc) in surface-active agents. This is not found in simple salts. The behavior may be assumed to be caused by some structural changes in the solute molecule as a result of dilution, and to be related to the existence of a so-called dilution-denaturation of deoxyribonucleic acid. In our preliminary experiment of light scattering in this system, no association of solute molecules was found. Therefore, the intramolecular changes by the action of the water molecule must occur above and below the c. i.

If the c. i. is plotted against the pressure, the maximum appears at about 2.0×10^3 atm, as is shown in the inset in Fig. 1. This is similar to the effect of pressure on the cmc, which has been found recently;⁹⁾ it seems to be very peculiar. The structural changes of water under high pressure¹⁰⁾ may be responsible.

Further study is now in progress.

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7) S. D. Hamann, "Physico-Chemical Effects of Pressure," Butterworths Scientific Publications, London (1957), p. 118.

8) F. Ascoli and C. Botré, *Biopolymers*, **1**, 353 (1963).

9) S. D. Hamann, *J. Phys. Chem.*, **66**, 1359 (1962); R. F. Tunddenham and A. E. Alexander, *ibid.*, **66**, 1839 (1962); J. Osugi, M. Sato and N. Ifuku, *Nippon Kagaku Zasshi (J. Chem. Soc. Japan, Pure Chem. Soct.)*, **87**, 329 (1966).

10) The open-structure of ice I transforms to a dense-ice-like-structure above about 2×10^3 atm; L. Hall, *Phys. Rev.*, **73**, 775 (1948).