On the Mono-molecular Layer of α-Aminolauric Acid Polymer

Keiichi EDA and Yukio MASUDA

(Received March 17, 1951)

Introduction

The researches which have been made on the monolayers of various high polymers, natural and synthetic, for the past twenty years gave many valuable suggestions on the chemical structures of these polymers, above all, of natural proteins.

This short paper describes the results of surface pressure and potential measurements on films of α-aminolauric acid polymer which was synthesized as a protein-like high polymer. This polymer was chosen because it contains nonpolar lauric acid residue only as the side chain and electrical properties of the film are mainly ascribed to that of its polypeptide portions.

Experiment

Force-area relations were measured with a Langmuir-Adam surface balance of which sensitivity is 0.3 dyne. The surface potential was measured simultaneously with a dynamic electrometer.(1) The brass tray used was heavily coated with paraffine. α-Aminolauric acid polymer was synthesized in the laboratory of Dr. H. Tani and Dr. J. Noguchi by the method of N-carbonic acid anhydride of amino acid. The molecular weight determined by the osmotic pressure measurement was 172,000, and the mean polymerization degree was 870.(2) It was spread on the water surface from benzene solution. Various pH solutions, and ammonium sulfate solutions were used as the substrates. All experiments were done at room temperature which was never above 15° or below 10°.

Results

Fig. 1 gives the results on distilled water, on $N/100$ HCl solution, and on $N/100$ NaOH solution. Full curves show the surface pressure, F, and the broken lines show the surface

---

(1) Cf., Rosenfeld and Hoskins, *Rev. Sci. Inst*, **16**, 343 (1945).

(2) H. Tani and J. Noguchi, *Jour. High Polymers, Japan*, **8**, 51 (1951).

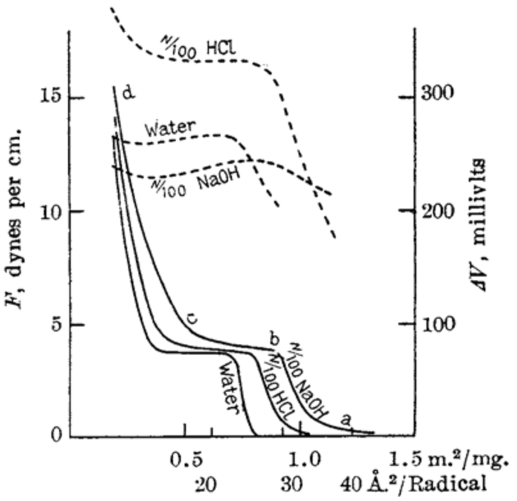

Fig. 1.—Various *p*H solutions.

potential change, ΔV, due to the films.

The whole shape of the curve resembles that of the transition curve shown by fatty acids. Each of the surface pressure area curves consists of three portions, a-b, b-c, and c-d. As the films on dilute solutions are highly compressible in the region, b-c, the curves are almost completely flat. The surface potential values fluctuate at large areas, but are stabilized at the concentration at which the surface pressure appeared (point a). On further compression lauric acid residues rise out of water surface and the surface potential increases rapidly up to a value at point b. It may be considered that in the highly compressible state, b-c, some transitions occur in the polypeptide main chain to form more compact structure. The nearly constant value of the surface potential in this region means that the compact form has a smaller normal dipole moment. The area decreased further, the surface pressure increases rapidly (point c). This sharp rise in surface pressure with compression indicates that at this point all the lauric acid residues are out of water and are packed closely as possible. The cross sectional area of a lauric acid radical is about 20 Å.² or less at zero compression. The effect of the hydroxyl ions on the spreading of the polypeptide is greater than that of the hydrogen ions. The values of the vertical component of the dipole moment per radical at point b are given below,

on distilled water	2.0×10^{-19} e.s.u. per radical
on $N/100$ HCl	2.8 ,,
on $N/100$ NaOH	2.3 ,,

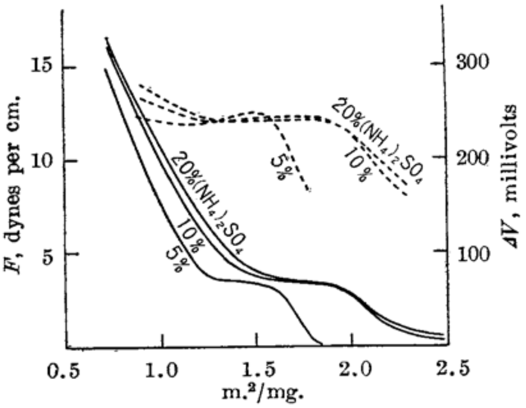

Fig. 2.—Salt solutions.

Fig. 2 exhibits the effect of salt concentrations of the substrate on the spreading. It seems probable that the large areas on the substrates of the increased concentrations are due to the adsorption of the salt ions.

The authors are grateful to Prof. B. Tamamushi for his kind guidance, and besides, to Dr. H. Tani and Dr. J. Noguchi for the provision of the polymer sample used in this work. A part of the expense of this study was defrayed from the Scientific Research Grant of the Ministry of Education.

Department of Physics and Chemistry,
Gakushuin University, Tokyo