CHEMISTRY LETTERS, pp. 1203-1204, 1974. Published by the Chemical Society of Japan

BRILLOUIN SCATTERING SPECTRA OF SURFACTANT SOLUTIONS

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Brillouin scattering was measured for aqueous solutions of potassium n-hexanoate and potassium n-octanoate. The sound velocity in the surfactant solutions increased successively with an increase in surfactant concentration, but it became almost constant at the critical micelle concentration.

Brillouin scattering spectroscopy has been used extensively for determining sound velocities in gases, liquids, and solids.1) Since the sound velocity depends on the structural properties of the medium, studies of Brillouin scattering in surfactant solutions will give us information on the nature of micelle formations. Accordingly, in the present study, Brillouin scattering in aqueous solutions of potassium n-hexanoate (Pn-H) and potassium n-octanoate (Pn-O) was measured at various concentrations and the dependence of the sound velocity on concentration was studied.

Measurements of Brillouin scattering were made at 23°C with the 632.8 nm radiation (an output power of about 50 mW) of a helium-neon laser. Light scattered at 90° was analyzed with a pressure-scanned Fabry-Perot interferometer.2) The refractive indices of the surfactant solutions were measured with an Abbe refractometer. The sound velocity, v, in the medium is given by1)

$$\Delta\nu/\nu_0 = \pm 2(v/c)\, n \sin(\theta/2), \qquad (1)$$

where $\Delta\nu$ is the frequency shift, ν_0 the frequency of the incident light, c the velocity of light, n the refractive index of the medium, and θ the scattering angle. From the observed frequency shifts of the Brillouin scattering, the sound velocities in the surfactant solutions were obtained by Eq. (1) for various concentrations. The Brillouin scattering spectra of the Pn-H solution with concentrations of 0.488 and 1.627 mol/l are shown in Fig. 1. In Fig. 2, the observed sound velocities are plotted against concentrations of the surfactants.

The sound velocity in the Pn-O solution increased with an increase in the concentration until it became almost constant around 0.6 mol/l. This concentration coincides with the reported values (0.4 – 0.6 mol/l) of the critical micelle concentration (CMC).3) The completion of the sound-velocity increase at the CMC is evidently due to the formation of micelles, indicating that sound velocities in surfactant solutions vary sensitively according to the degree of aggregation of surfactant molecules. Similar observations made for the Pn-H solution give the CMC of 1.5 mol/l, which is again in agreement with the previous values of 1.5 – 1.6 mol/l.3)

It is noted that in the Pn-O solution the second variation of the sound velocity took place at the concentration of 1.4 mol/l. This concentration is close to the second CMC of 1.2 mol/l observed for sodium n-octanoate.[4)] Accordingly this sharp increase in sound velocity may be ascribed to the change of micelle shapes. At the second CMC, the realignment of constituent molecules of micelles brings about the variation of sound velocity. Thus measurements of Brillouin scattering are useful for studying the nature of micelles, together with other methods so far employed.[5)]

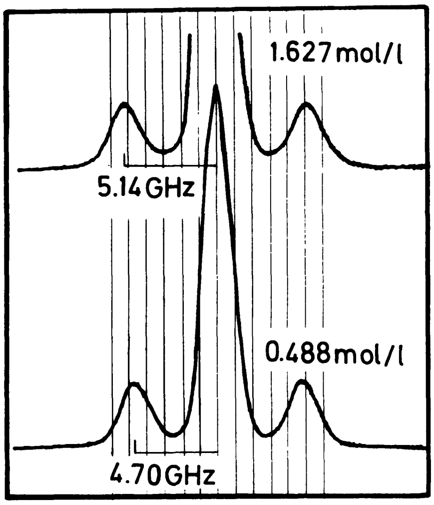

Fig. 1. Brillouin scattering spectra of Pn-H solution.

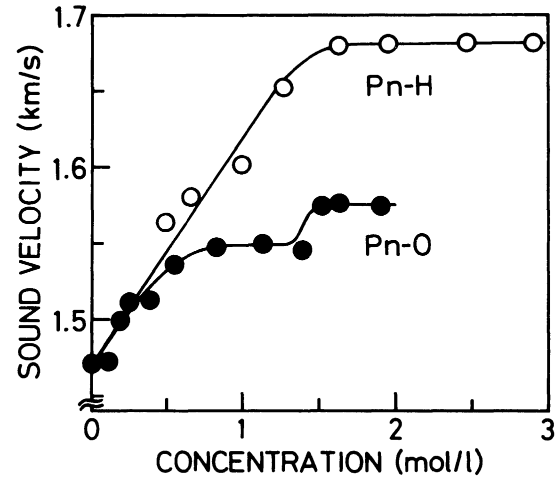

Fig. 2. Variation of the sound velocity with surfactant concentration.

References

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(Received August 24, 1974)