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Figure 1 and Figure 2: temperature dependences of dielectric permittivity

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Abstract

Full Text

PHYSICAL CHEMISTRY

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ON THE DISPERSION OF THE DIELECTRIC PERMITTIVITY IN THE CRITICAL REGION OF BINARY LIQUID SYSTEMS

(Presented by Academician A. V. Shubnikov on 16 XII 1961)

In studying the behavior of the dielectric permittivity and dielectric losses in the critical region of demixing of binary liquid systems, the phenomenon of dispersion of the dielectric permittivity was discovered, which is observed especially distinctly in the supercritical region*, at the critical concentration and when measurements are made in the region of low (audio) frequencies. With a small departure from the critical concentration, the observed dispersion becomes smaller, and then, upon further departure from the critical concentration, is not observed at all.

Fig. 1. Temperature dependence of the dielectric permittivity for the nitrobenzene–hexane system at concentrations of nitrobenzene in hexane (in mol. %):
1 –39.3; 2 –41.167; 3 –41.45; 4 –42.95

Fig. 2. Temperature dependence of the dielectric permittivity for the nitrobenzene–hexane system at concentration $C = 41.167$ mol. % nitrobenzene in hexane and frequencies (in kHz):
1 –3; 2 –4; 3 –5; 4 –6; 5 –10 (upper branch), 5 –20 (lower branch)

Figure 1 shows how this occurs in the nitrobenzene–hexane system at the critical concentration and at concentrations close to it. Figure 2 shows that in the supercritical region there exists not only a temperature- but also frequency dispersion of the dielectric constant, clearly observed in the nitrobenzene–hexane* system with a concentration $C = 41.167$ mole % nitrobenzene in hexane, in the region of low (acoustic) frequencies.

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* That is, in such a temperature region which directly adjoins the critical point and in which the system is single-phase.

Fig. 3

Figure 2: Fig. 3

Figure 3 gives the temperature dependence of the dielectric constant and of the loss-angle tangent for the same system. From this figure it is clearly seen that dispersion occurs more than 5° before the critical demixing temperature, i.e., at the beginning of the critical region, where the system is single-phase.**

The region of the observed dispersion is the region in which fluctuations begin to develop in the system; these fluctuations attain their maximum value at the critical temperature, the temperature of phase identity, where, as is clearly seen in Figs. 1 and 3, the dielectric constant and the losses pass through sharp maxima coinciding in temperature.

It should be noted that the dielectric constant and the losses pass through maxima at the critical temperature also for one-component liquid—vapor systems (1), and that dispersion of the dielectric constant is also observed there in the supercritical region (1,2). We note that we have not been able to find in the literature data on the dispersion of the dielectric constant for binary liquid systems in the critical region.

Fig. 3. Temperature dependence of ε and $\operatorname{tg}\delta$ for the nitrobenzene—hexane system at $C = 41.167$ mole % nitrobenzene in hexane and a frequency of 5 kHz.

Therefore, the phenomenon discovered is of interest both from the standpoint of the theory of dielectrics and with regard to the possibilities for studying the molecular mechanism of supercritical phenomena.

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REFERENCES CITED

[1] J. G. Powles, C. R., **230**, 836 (1950).
[2] C. P. Smyth, C. S. Hitchcock, J. Am. Chem. Soc., **56**, 1084 (1934).
[3] *Collection: Physics of Dielectrics*, Proceedings of the II All-Union Conference on the Physics of Dielectrics, USSR Academy of Sciences Press, 1960, p. 49.
[4] V. K. Semenchenko, K. V. Arkhangel' skii, *ZhFKh*, **33**, 230 (1959); *ZhFKh*, **35**, 927 (1961).

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* The same is observed in the systems: nitrobenzene—heptane and nitrobenzene—octane.

** And, consequently, there are no opalescences (inhomogeneities) or layers.