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"Remake" of the non-linear dielectric effect in investigations of structure of liquids

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Structure of matter is determined by electrical interactions between molecules: dipole-dipole, dipole-ion, ion-ion interactions. Impact of an electric field on a matter allows to investigate these interactions and to understand the structure and dynamics of the investigated system. When a dielectric (in this case a liquid) is influenced by an external electric field, it undergoes polarization. For low-intensity field, the polarization is proportional to the field. However, if we increase the intensity of the electric field saturation effects could be expected. The measure of the so-called "non-linear dielectric effect" (NDE) is a nonlinear dielectric increment defined as the difference of the electric permittivity measured in a strong and in a weak electric field intensity: $\Delta\varepsilon_{NDE} = \varepsilon_E - \varepsilon_{E->0}$. According to Debye classic theory, in liquids consisted of dipolar molecules, the increment should be negative and proportional to the square of the electric field. In many liquids, these requirements are fulfilled. Interestingly, deviations from the classical behaviors are sometimes observed. This happens when a strong external electric field affects conformation of molecules, disturbs association equilibria, significant deviations are also observed in the vicinity of phase transformations. NDE experiments were popular in the last decades of the 20th century. Measurements are difficult and commercial equipment for these studies is scarce. This may explain the recent decrease of interest in this particular technique. The report will present the NDE investigations of association phenomena in alcohols and critical phenomena in the vicinity of phase transformations. The details of the NDE experiment will be also presented. I firmly believe that a proper presentation of possibilities offered by a non-linear dielectric effect will cause an increase of interest in these studies and restore their rightful place in investigations of chemistry and physics of matter.

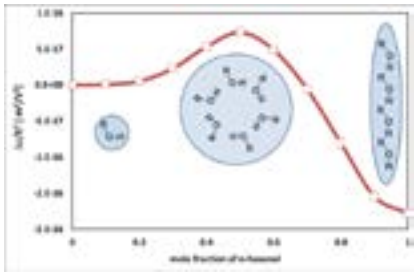

Figure: Piekara factor in n-hexanol-hexane mixture

Recent Publications

1. Nowak J and Malecki J (1985) Dielectric studies of conformational equilibria in acetylphyiridines. Chem. Phys. Lett. 116(1):55-57.
2. Kosmowska M and Orzechowski K (2010) Non-linear dielectric effect and critical phenomena in a ternary mixture cyclohexane + acetonitrile + p-xylene. J. Non Cryst. Solids. 356(1):815-817.
3. Orzechowski K et al. (2014) Shift of the critical mixing temperature in strong electric fields: theory and experiment. J. Phys. Chem. B. 118(25):7187-7194.

Biography

K Orzechowski specialized in physical and theoretical chemistry. He is currently a Professor at the University of Wroclaw, Poland. His research concerns physics and chemistry of dielectrics, phase transitions, intermolecular interactions, application of research in medicine, especially in cancer detection.

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