

Study of Aqueous Solutions: A Dielectric Spectroscopy Approach

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Abstract : The time domain dielectric relaxation spectroscopy (TDRS) probes the interaction of a macroscopic sample with a time-dependent electrical field. The resulting complex permittivity spectrum, characterizes amplitude (voltage) and time scale of the charge-density fluctuations within the sample. These fluctuations may arise from the reorientation of the permanent dipole moments of individual molecules or from the rotation of dipolar moieties in flexible molecules, like polymers. The time scale of these fluctuations depends on the sample and its relative relaxation mechanism. Relaxation times range from some picoseconds in low viscosity liquids to hours in glasses, Therefore the DRS technique covers an extensive dynamical process, its corresponding frequency range from 10⁻⁴ Hz to 10¹² Hz. This inherent ability to monitor the cooperative motion of molecular ensemble distinguishes dielectric relaxation from methods like NMR or Raman spectroscopy which yield information on the motions of individual molecules. An experimental set up for Time Domain Reflectometry (TDR) technique from 10 MHz to 30 GHz has been developed for the aqueous solutions. This technique has been very simple and covers a wide band of frequencies in the single measurement. Dielectric Relaxation Spectroscopy is especially sensitive to intermolecular interactions. The complex permittivity spectra of aqueous solutions have been fitted using Cole-Davidson (CD) model to determine static dielectric constants and relaxation times for entire concentrations. The heterogeneous molecular interactions in aqueous solutions have been discussed through Kirkwood correlation factor and excess properties.

Keywords : liquid, aqueous solutions, time domain reflectometry

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