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Time Domain Dielectric Relaxation Microwave Spectroscopy

Authors : A. C. Kumbharkhane

Abstract : Time domain dielectric relaxation microwave spectroscopy (TDRMS) is a term used to describe a technique of observing the time dependant response of a sample after application of time dependant electromagnetic field. A TDRMS 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 TDRS technique covers an extensive dynamical process. The corresponding frequencies 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. Recently, we have developed and established the TDR technique in laboratory that provides information regarding dielectric permittivity in the frequency range 10 MHz to 30 GHz. The TDR method involves the generation of step pulse with rise time of 20 pico-seconds in a coaxial line system and monitoring the change in pulse shape after reflection from the sample placed at the end of the coaxial line. There is a great interest to study the dielectric relaxation behaviour in liquid systems to understand the role of hydrogen bond in liquid system. The intermolecular interaction through hydrogen bonds in molecular liquids results in peculiar dynamical properties. The dynamics of hydrogen-bonded liquids have been studied. The theoretical model to explain the experimental results will be discussed.

Keywords : microwave, time domain reflectometry (TDR), dielectric measurement, relaxation time
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