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News

RESEARCH WITHIN DIELECTRIC SPECTROMETRY AT THE UNIVERSITY OF BAYREUTH

At the University of Bayreuth, Germany, the Faculty of Physics has a tradition in investigating physical properties of matter. Different techniques are employed to investigate the molecular structure and dynamics of various substances: dielectric spectrometry, nuclear magnetic resonance (NMR) relaxometry, light scattering.

During 2006, I had a postdoctoral stage in the Dielectric Spectrometry Laboratory of Bayreuth University. The postdoctoral project was entitled "High precision dielectric measurements for the characterization of liquid polymer dynamics at low frequencies" and it was sponsored by German Research Foundation.

The project studied polymer dynamics, in particular, the response of the polymers to low frequency electric fields. The dielectric properties of polymers and their relaxation characteristics were investigated by high precision broadband dielectric spectroscopy. One of the best broadband dielectric spectrometers was employed for this task. In addition to broadband dielectric spectrometer, a high-precision bridge was employed to measure dielectric permittivity.

The knowledge of dielectric properties and relaxation characteristics is very important for the analysis of electromagnetic field absorption in matter, including biological materials, tissues and organs. It is well known that biological tissues contain polymers that, through their dielectric properties, influence the absorption characteristic of electromagnetic fields in human body.

To determine the dielectric characteristic feature of polymers and the differences in polymer dynamics comparing to simple molecules, many substances have been investigated. At the beginning of the study, simple liquids were measured to achieve a database with dielectric spectra of simple substances to be used when analyzing the peculiarities of polymers dielectric spectra. Later, there were investigated various type of polymers that contain as monomers different types of molecules. Also, for each type of polymer based on a specific monomer, there have been measured polymer chains with various lengths.

The results of dielectric measurements showed higher dielectric losses at low frequencies in polymers compared to simple substances. An increased absorption of electromagnetic fields is observed at frequencies lower than the peak of absorption spectrum.

The study also emphasized a dependence of electromagnetic field absorption with the molecular weight – the length of polymer chain. Moreover, for various types of

polymers, we found similar manners of dependence of absorption with the molecular weight. However, the exact amount of absorption is highly dependent on polymer type.

All these characteristic features of dielectric spectra of polymers indicate an additional absorption mechanism compared to simple substances. The additional absorption in polymers dielectric spectrum represents a significant percentage of the maximum absorption. Thereby, the additional high-absorption region is of great importance in the assessment of electromagnetic field absorption in polymer molecule at low frequencies.

Human tissues contain biopolymers that, through their dielectric properties contribute to the global absorption characteristic of electromagnetic fields. Future dissymmetric studies should take into account the polymer effect and should emphasize the influence of biopolymers on the total absorption of electromagnetic fields in biological bodies. Therefore, further dielectric measurements on biopolymers, especially at low frequencies, are needed.

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