

Nano Seminar

Interfacial Water—from the Ordered Structures to the Single Hydrated Shell

Prof. Yuri Feldman

Department of Applied Physics, the Hebrew University of Jerusalem

Abstract:

Water is the universal solvent in nature. Does this imply, however, that its interaction with its environment is also a universal feature? While this question maybe too fundamental to be answered by one method only, we present evidence that the broadening of the dielectric spectra of water presents universal features of dipolar interactions with different types of matrixes. If in aqueous solutions the starting point of water's state can be considered as bulk, with only partial interactions with the solute, then the state of water adsorbed in heterogeneous materials is determined by various hydration centers of the inhomogeneous material (the matrix) and it is significantly different from the bulk. In both cases, the dielectric spectrum of water is symmetrical and can be described by the Cole–Cole (CC) function. The phenomenological model that describes a physical mechanism of the dipole–matrix interaction in complex systems underlying the CC behavior has been applied to water adsorbed in porous glasses [1], clays [2] and hydrated proteins [3]. It was then extended to analyses of the dynamic and structural behavior of water in nonionic and ionic aqueous solutions [4-7]. The same model is used to analyze the CC relaxation processes in the Red Blood Cells (RBC) suspensions by monitoring the RBC cytoplasm under different external conditions. Dielectric measurements of RBC suspensions in the frequency region of 100 MHz to 50 GHz as a function of aging or external glucose contartion also reveal a distinct time point or glucose concentration after which the spectra are radically changed. This opens a window of opportunity to exploit this for the non-invasive monitoring of diabetes or to non-invasive control of the quality of Stored RBC in a Blood bank in order to manage the inventory.

References

- [1] A. Puzenko, P. Ben Ishai, Y. Feldman, Cole-Cole Broadening in Dielectric Relaxation and Strange Kinetics, *Phys. Rev. Lett.*, 105 (2010) 037601-037604.
- [2] M.A. Vasilyeva, Yu. A. Gusev, V.G. Shtyrlin, A. Greenbaum (Gutina), A. Puzenko, P. Ben Ishai and Yu. Feldman, "Dielectric Relaxation of Water in Natural Layer Aluminosilicates", *Clays and Clay Minerals* (2014), Vol. 62, pp. 62–73.
- [3] Y. Kurzweil-Segev, A. Greenbaum (Gutina), I. Popov, D. Golodnitsky and Yu. Feldman "The role of the confined water in the dynamic crossover of a hydrated Lysozyme powders", *PCCP* (2016, in press)
- [4] E. Levy, A. Puzenko, U. Kaatzte, P. Ben Ishai, Y. Feldman, Dielectric spectra broadening as the signature of dipole-matrix interaction. I. Water in nonionic solutions, *J. Chem. Phys.*, 136 (2012) 114502-114505.
- [5] E. Levy, A. Puzenko, U. Kaatzte, P. Ben Ishai, Y. Feldman, Dielectric spectra broadening as the signature of dipole-matrix interaction. II. Water in ionic solutions *J. Chem. Phys.*, 136 (2012) 114503-114506.
- [6] A. Puzenko, E. Levy, A. Shendrik, M.S. Talary, A. Caduff, Y. Feldman, Dielectric spectra broadening as a signature for dipole-matrix interaction. III. Water in adenosine monophosphate/adenosine-5'-triphosphate solutions, *The Journal of chemical physics*, 137 (2012) 194502-194508.
- [7] E. Levy, S. Cerveny, I. Ermolina, A. Puzenko, Y. Feldman, Dielectric spectra broadening as a signature for dipole-matrix interaction. IV. Water in amino acids solutions, *J. Chem. Phys.*, 140 (2014) 135104-135101-135106.

Gathering & Refreshments at 10:50

Please contact Liron Dover at 6584919 if you are interested in meeting the lecturer.

Sunday, Mar. 27th 2016, 11:00 at the Seminar Hall
Los Angeles Building, entrance floor.