Control of the stability and function for globular proteins by inclusion into the novel type complex environments – self-assembled films and ionic glass-like blends

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Thermodynamic stability (versus temperature-induced phase transitions), conformational flexibility and transformations (hierarchical structural changes), as well as functional performance (specific biological activity) of globular proteins, (typical water soluble "biomolecular machines") exhibit remarkable diversity. Understanding of physical mechanisms for these phenomena at the molecular level is of paramount importance for the mankind from the viewpoints of the both, general cognition of living matter, as well as practical purposes. Our systematic, interdisciplinary research activity mainly includes thermodynamic and kinetic experimental studies, whereas analysis of the obtained data we perform on the basis of contemporary theoretical concept. The technical basis and equipment for our research are located at the Institute of Biophysics and Bionanosciences of the Department of Physics, TSU and Department of Biophysics of I. Beritashvili Center of Experimental Biomedicine. We also practice systematic collaboration with a number of universities of the USA and Germany.

Among the results of research work accomplished in 2015, the following should be mentioned: [1] Studies of electron exchange within the biomimetic nano-dimensional system composed of the copper ion entrapped inside the Au-deposited self-assembled L-cysteine monolayer film, between the Cu ion and the Au-electrode, under the variable temperature and pressure conditions. These studies disclosed the milieu impact that is known as characteristic for cases of the environment's nonergodic and nonlinear response to the ET process; [2] Studies of electron exchange between the carrying glassy carbon (GC) electrodes decorated by the polymer-modified single walled carbon nanotubes (SWCNT), and the immobilized redox-active, enzymatically active protein, glucose oxidase (GOx). The redox-active cofactor of GOx, flavine adenine dinucletide (FAD) is actually involved in two-proton coupled two-electron exchange with the electrode. Our studies revealed that the activated SWCNTs, are able to penetrate into the active center of GOx and directly interact with two FAD moieties within the GOx interior (providing electronic "direct wiring"), thus to virtually act as nano-electrodes. This action is followed by the concerted redox process specified above; and [3] The horse muscle myoglobin (Mb) was involved in the electron exchange with Au electrodes modified by dissimilar, thin or thick alkanethiol SAMs, terminated either by uni-component (–OH), or 1:1 mixed (–OH/–COOH) groups, respectively. The systematic, temperature- and pressure-supported voltammetry studies perfectly confirmed certainty of two kinds of ET patterns for Mb, embodying: (a) different operational kinetic regimes (including protein's freely diffusing and strongly confined motifs), and: (b) different intrinsic physical mechanisms (including dynamically controlled and non-adiabatic motifs).

Publications:

[1] D.E. Khoshtariya, T.D. Dolidze, T. Tretyakova, R. van Eldik, J. Phys. D: Appl. Phys., 2015, v.48, Article No. 513699, (11 p.); [2] Y. Liu, T.D. Dolidze, S. Singhal, D.E. Khoshtariya, J. Wei, J. Phys. Chem. C 2015, v.119, p.14900-14910; [3] T.D. Dolidze, M. Shushanyan, D.E. Khoshtariya, J. Coord. Chem., 2015, v.68, p.3164-3180.