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"Optical Manipulation of Biological Matter: New Results, Ideas and Innovative Thoughts" A Review

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A new highlighted scientific domain emerged recently in the physical sciences: optical manipulation of matter [1]. Two main characteristics define the novelty of this different approach: 1- The new techniques use the range of visible light (not/poorly absorbed) a clear departure from the canonic spectroscopic methods based on electronic transitions. 2- The new techniques induce electric interactions by macromolecular *polarization effects*, a novel addition to the molecular/cellular interactions in mesoscopia. Our group reported, as far as we are informed, for the first time a possible optical manipulation of *biological macromolecules*, which reveal new material properties in their optically induced mesoscopic textures. In a first published paper Comorosan et al. [2] reported that optical manipulation/irradiation with high-density-green-photons- λ=514 nm (HDGP) induces a clear inhibition of free radicals generation in cellular and chemical systems. This novelty opens the way to introduce the electromagnetic field (EMF) as an addition to the classic arsenal of chemical antioxidant therapy.

The green light (GL) irradiations were performed with 10^3 lumens-light-emitted diodes, mounted on copper ventilated radiators. A monochromatic light of high-density-green-photons (HDGP), λ=514 nm, was obtained, with intensities up to 4.10^5 Lx. Samples of 2 ml enzyme, placed on Petri dishes (Φ=30mm) were irradiated with a flux of 10^4 Lx ($1.5*10^{-3}$ Wcm^{-2}), measured by a digital Luxmeter LX-1102, for 15 or 30 min., as appropriate for each experimental set-up.

In the same context we reported that HDGP- optical manipulation induces a clear protection of the classic "free radicals scavenger enzymes" SOD (superoxide dismutase) and CAT (catalase) against their denaturation with ultraviolet (UV) light. Comorosan et al. reported this new result in an international meeting [3,4].

In a different context we studied the physical characteristics of the HDGP- optical manipulated protein macromolecules, by a series of physical techniques: circular dichroism, fluorescence and Raman spectroscopy, zeta potential, SEM (single electron microscopy) and AFM (atomic force microscopy). Comorosan et al. [5] detailed the structural parameters of the respective physical transitions and the respective new helical conformation.

For a molecule of protein (Bovine Serum Albumin) the UV-irradiation induces a loss of 2.25 ± 0.1 % in the α-helix molecular content, with a loss of 1.65 ± 0.1 % in the α- helix molecular content of the HDGP "protected" molecule. This result revealed the clear antioxidant properties of the HDGP.

In a subsequent elaborated study we reported a theoretical- physical basis for the conformational transitions induced in biological systems by HDGP manipulation and advanced the new concept of *biological optical matter* [6].

In a series of experiments performed on optical manipulated protein molecules we revealed conformational changes that generate new specific properties. The fluorescence spectrum of the amylase-protein presents a decrease in the 340 nm fluorescence of the HDGP-manipulated protein. This effect may be assigned to a partial polarization of the C=O bond into C-O-. The observed sift of the fluorescence peak towards higher energies (from 340-334 nm) clearly suggests an electric interaction between the localized peptide structures.

In the Raman spectra, the optical manipulated enzymes present a larger PWHH (peak with a half-height) than the native enzymes which may be assigned to unfolded helix residues (about 12%) in α -helical space, consistent with CD observations.

All the above results suggest that under our new technique of optical manipulation with HDGP the protein molecules acquire a different macromolecular conformation with novel properties. In a series of experiments under way in our laboratory we observed a high stability of the manipulated molecules (long lived metastable states) over ~240 hrs. We tentatively termed this different class of identified new protein conformations as *Polarized- P*- Proteins*.

A new highlated domain emerged recently concerning interactions between protein molecules (PPI). These interactions depend mainly on the electronic topology of the molecular surface. Since the molecular charges on the Polarized-P*- Protein surface are specific to the novel conformation, we advance the hypothesis that this conformation will interact differently in the PPI- experiments. In this context the introduction of our polarized- P* proteins may represent a significant different approach and could represent an innovation.

A series of studies concerning optical manipulation of biological materials were published recently [7-9].

Main Conclusions

We advanced an innovative concept, the biological optical matter. Before us, the concept covered mainly structures outside the protein and nucleic acids level.

We revealed a different protein molecular configuration: the polarized- P* protein. In this context we advanced an innovative thought: to use this new type of protein configuration in the highlighted domain of protein- protein interactions and drug design.

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