Polymer films made with bacteriorhodopsin and its derivatives as an example of photosensitive material for recording, processing and storage of optical information.

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Abstract - Bacteriorhodopsin (BR) – nanostructured component of purple membrane (PM) which is located in plasmatic membrane of *Halobacterium salinarium* cells (1). Photoisotropic and photoanisotropic properties of polymer films made with BR and some BR derivatives are presented in order to illustrate the potential of such samples for different application. The dynamic holography recording on gelatin films made with 14-fluorobacteriorhodopsin, both the wild type as well as its D96N mutant, has been performed using the photochromic (isotropic) properties of these BR derivatives (Fig.1). It was shown that sequential application of blue and red laser beams reveals that the photochromic properties of 14-F BR gelatin films might be successfully applied for holographic storage and associative memories. On the other hand it is shown that gelatin films based on native BR and its 4-keto BR derivatives exhibit a nonlinear photoinduced anisotropy. Data is presented showing the correlation between the laser induced anisotropic properties and the chromophore/protein interaction (Fig.2, Fig3). The anisotropic properties of the 4-keto BR derivatives allows to demonstrate the importance of the photoinduced dichroism method to estimate the rigidity of the chromophore bound to the protein and to extend the range of application of such systems to real-time optical processing.

The dynamic holography recording on gelatin films made with 14-fluorobacteriorhodopsin, both the wild type as well as its D96N mutant, has been performed using the photochromic (isotropic) properties of these BR derivatives. Low- intensity red light from cw He-Ne laser (λ=633 nm, $I_{1,2}$=170 mW/cm^2) is applied for dynamic holography recording. It has been found experimentally that a pre-illumination of blue light (cw He-Cd laser, λ=442 nm with I=70 mW/cm^2) increases the diffraction efficiency of holography grating in a case of both 14-F WT and 14-F D96N gelatin films (Fig.1, a) and b)). A character of a possible blue-shifted photoproduct as a target of blue pre-illumination is discussed. This blue-shifted photoproduct can not be related to the M-like intermediate because a lifetime of the M-species in gelatin film under the blue light illumination with identical intensity is at most 100 ms. It may speculate that a P-like intermediate is formed under the red light irradiation of He-Ne laser. Although O-intermediate isn't formed in the polymer film based on BR and red light does not provide a usual way for P- and Q-like intermediate generation from O-intermediate, a small amount of P-intermediate could be directly formed by excitation of the laser-induced blue membrane. Alternatively this blue-shifted photoproduct might be related to the minor absorption band in the 440 nm range for 14-F BR, which would not be involved in the photocycle . Even the phototransformations of a very small quantity of this photoproduct can contribute to the holographic recording kinetics.

On the other hand it was shown that gelatin films based on native BR and its derivatives 4-keto BR exhibit a nonlinear photoinduced anisotropy. Characteristics of nonlinear photoinduced anisotropy of these samples form the foundation to a model of anisotropic photoselection of pigment's molecules under linearly polarized light. The data are presenting showing the correlation between the laser induced anisotropic properties and chromophore/protein interaction. Using the anisotropic properties of the initial state B and the photoinduced state M in the WT BR and 4-keto BR pigments allows to demonstrate that changes in molecular dichroism reflect the weakening of the chromophore-protein interaction (and not just a configurational change of the chromophore) in BR.

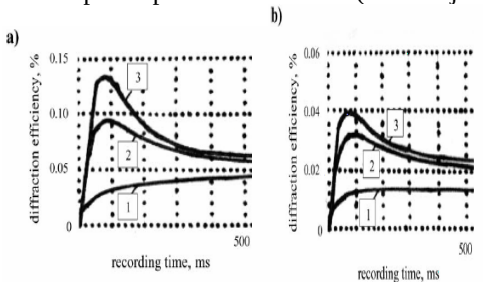

Fig.1 First-order self-diffraction holographic kinetics of the 14-F WT (a) and 14-F D96N (b) pigments, with no blue pre-illumination (curves 1) and with 30s (curves 2) and 60 s (curves 3) duration of blue pre-illumination.

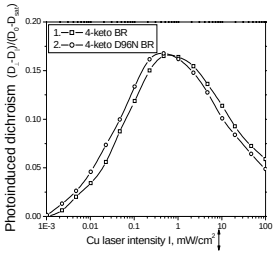

Fig.2 Experimental dependence of the photoinduced dichroism on the intensity of the linearly polarized Cu laser beam (λ=510 nm) for 4-keto WT BR and 4-keto D96N BR at λ_{test}=510 nm. D_0 is the initial optical density, D_{sat} is a residual absorption at λ_{test}= 510 nm upon saturation intensity irradiation.

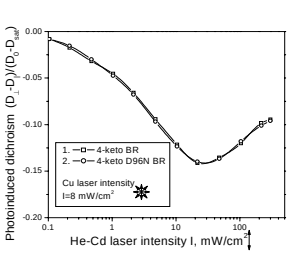

Fig.3 Experimental dependence of the photoinduced dichroism on the intensity of the linearly polarized He-Cd laser (λ=442nm) at λ_{test}=510 nm. The intensity of the Cu laser (λ = 510 nm) is con stant and the beam is naturally polarized.

1. N.Hampp, Chem. Rev. 100 (2000) 1755-76