Науково-дослідна робота

"Хіміко-фізичні аспекти створення новихфотоактивних полімерних композитів для інформаційних технологій і чистої енергетики",
тема № 19БФ037-08,
науковий керівник М.О.Давиденко, кафедра Хімії високомолекулярних сполук.

"Chemico-physical aspects of the development of new photoactive polymer composites for information technologies and green energetic"
№19БФ037-08
Group leader: M. Davidenko, Department of Macromolecular Chemistry.

Group Members:

Dr. Mykola Davidenko	Dr. Larisa Tonkopieva
Dr. Sergey Studinsky	Dr. Svitlana Petrusenko
Dr. Mykola Chuprina	Dmitry Vyshnevsky
Dr. Olena Mokrinska	Valeriy Pavlov
Dr. Valeriia Ovdenko	Mykola Kuranda

Object of research: Photovoltaic and polarization-sensitive films of polymer composites (FPC) doped with dyes, new ligands and their metal complexes, fullerenes, graphenes, nanoparticles of noble metals and inorganic semiconductors.

Subject of research: Mechanisms of photoconductive properties and photo-induced anisotropy in FPC, establishing correlation between these properties and the structure of polymer matrix and the dopant.

Description of the problems to be addressed by the study.

The development of highly efficient photosensitive materials for information technologies and green energetic.

Fundamental aspect: elucidation of the peculiarities of photo-physical processes of excitation, intra- and intermolecular transfer and dissipation of energy and electric charge in the doped FPC. Establishment of the "structure-properties" dependence of these processes.

Practical aspect: new materials with improved properties and predetermined characteristics for optical sensors development and for application in information technologies and energy saving; efficient conversion of light energy into electrical by using photovoltaic cells.

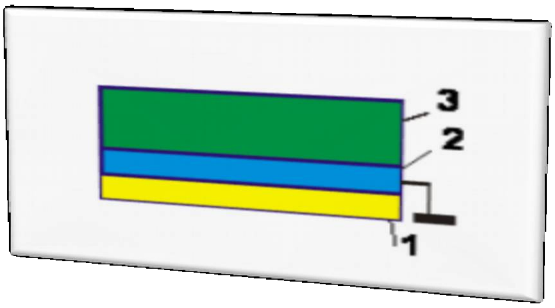
The goal of the work. Photosensitive FPC properties investigation by the chemico-physical methods and development of methods to optimize them by modification of polymer matrix and dopant molecules for optical sensors in high technologies and green energetic.

The results previous researches are shown on the website http://photonics.kiev.ua/ , in particular:

Holographic Rewritable Recording media

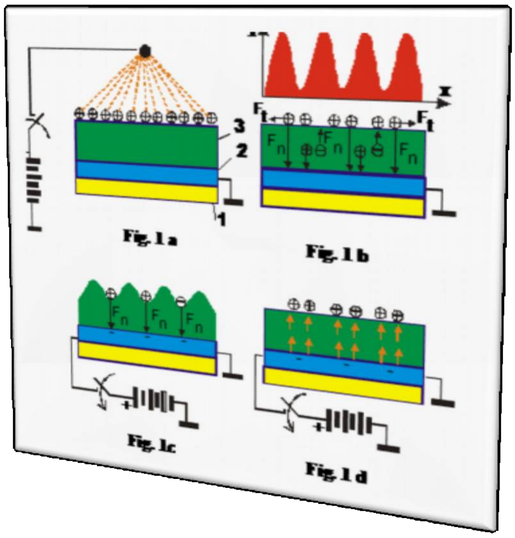
Three main building blocks

- 1–The glass plate
- 2–ITO (Indium tin oxide)
- 3–The holographic recording medium based on dye doped glycidyl carbazole–butyl glycidyl ether cooligomer films as a photoconductivity.

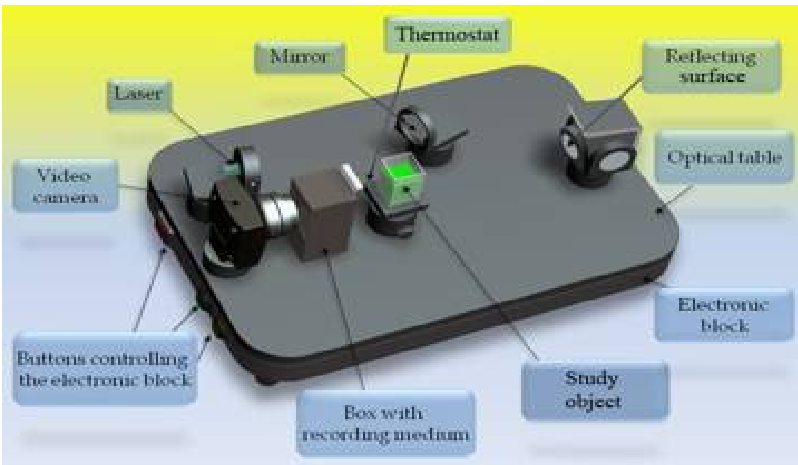


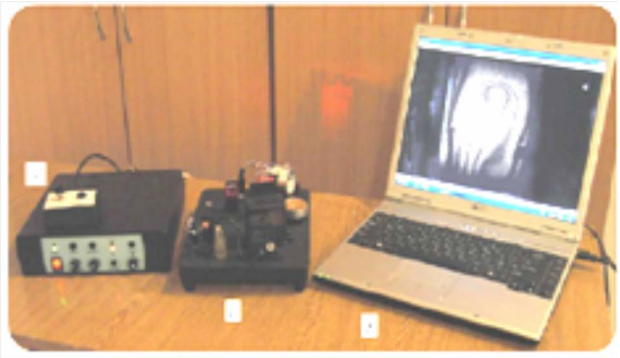
Photothermoplastic holographic recording

- Technical Data
- Diffraction efficiency – 25%
- Spatial frequency lines/mm 500…1500
- Life Cycles – 3000
- Time of development 1…5ms
- Time for erasing and exposure ready (charging) – 1.5 seconds
- Signal-to-noise ratio of reconstructed image – 500
- Hologram Lifetime – > than 10 years
- Spectral sensitivity: 400 - 800 nm
- Resolution: (range): 200 - 1500 I/mm (optimum): 350 - 1000 I/mm



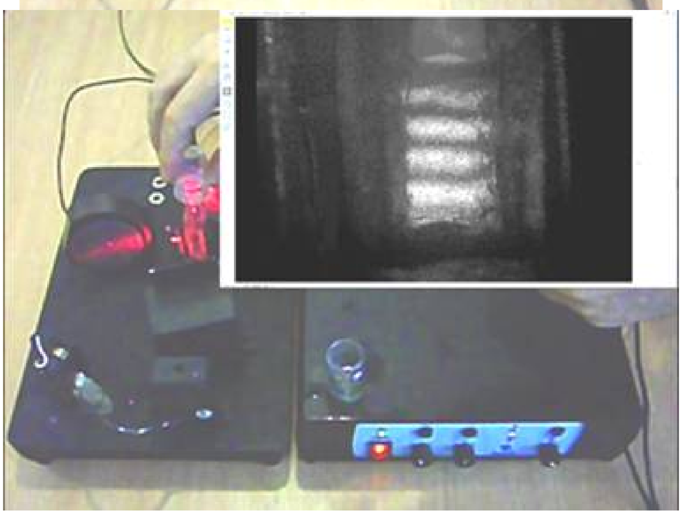
Small sized holographic interferometer





The photo of the screen on which the reproduced image of the car hologram is projected.

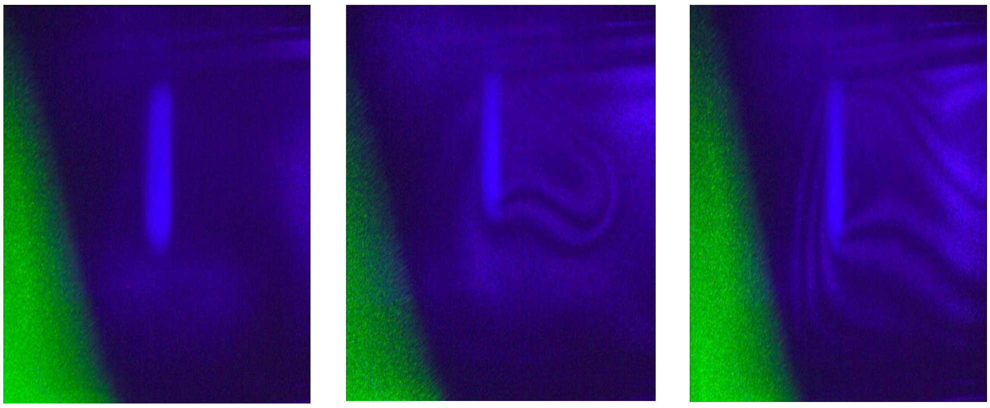
The photo of the general view of a modernized small-sized holographic installation for refractive index determination.



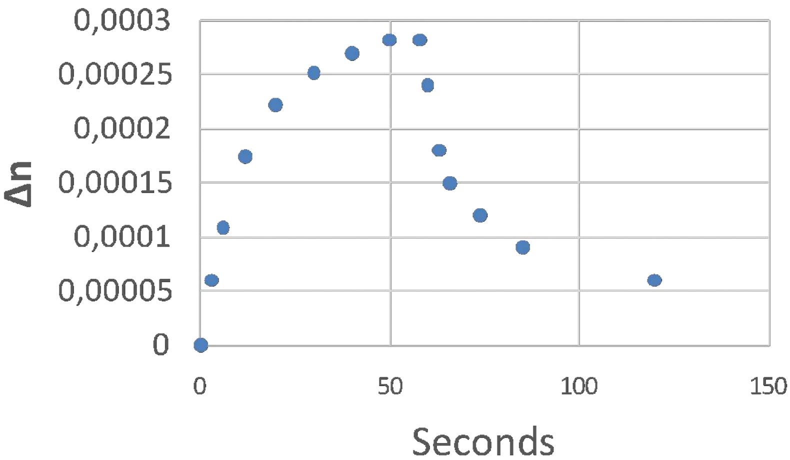
The photo of the process of filling the cuvette with sucrose aqueous solution and its display on the monitor.

Photothermoplastic recording media and their utilization in photochemical reactions kinetics study.

Photochemical reaction with Rhodamine C

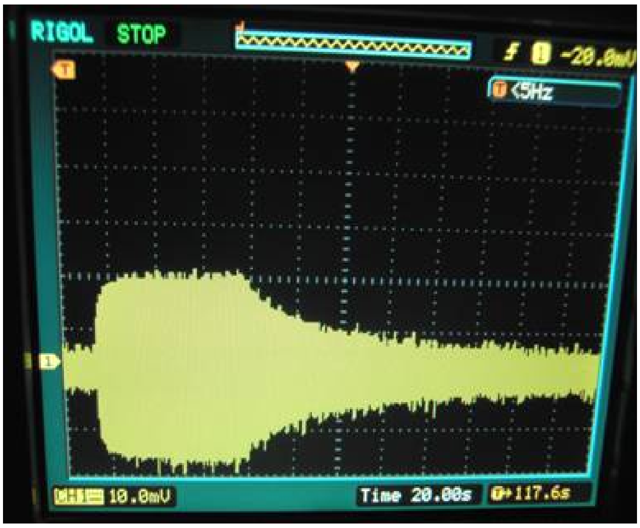


Holography interference images for Rhodamine C experiment: A) liquid sample before irradiation; B) liquid sample, beginning of the reaction (2nd second), C) liquid sample, development of the reaction (4th second).

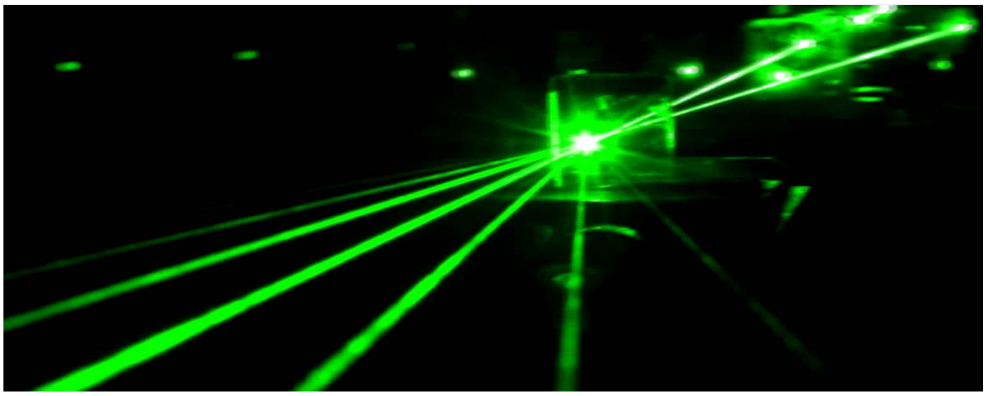


Investigation of photovoltaic properties in films of oligomers with sensitizers of a diverse nature

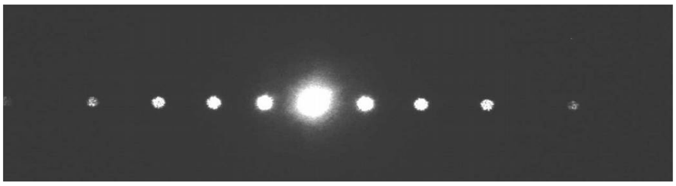
Measurement of surface potential of thin films under irradiation (by Kelvin method)

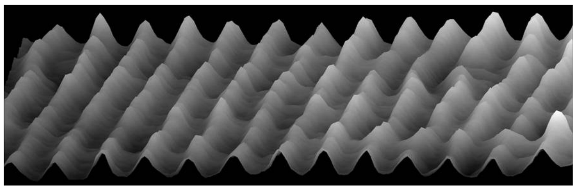


Recording media for polarizational holography with diffraction efficiency driven by electrical field



An example of using a diffraction grating for a light beam splitting

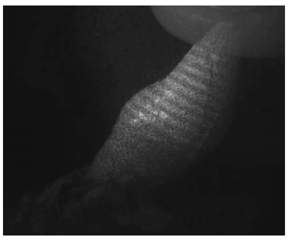




Recording of polarization diffraction gratings and formation of a regular relief on the polymer films surface

Experimental studies of biological objects by the holographic interferometry methods have been started

Some research results are presented in photos of the tooth and its interferograms



Synthesis of new photosensitive materials (polymer matrix and organic dyes)

One of the areas of work is the synthesis of new photochromic materials, the development of polymers and polymeric composites based on them, the study of its photophysical and photochemical properties in solutions and thin films.

A characteristic feature of the synthesized molecules is the presence of several photochromic fragments, which can be combined in a single dopant molecule and / or a monomeric unit of the polymer.

Work is underway with such classes of photochromic compounds:

- azobenzenes
- azomethines
- spiropyranes
- chalcones

Selected publications:

1. Davidenko N.A., Davidenko I.I., Studzinsky S.L., Pavlov V.A., Mokrinskaya E.V., Chuprina N.G., Kravchenko V.V. Some features of information properties of holographic recording media based on a photoconducting carbazolyl-containing oligomer doped with an organic electron acceptor. // Applied Optics.- 2016.- V.55, N12.- P.B31-B35. https://doi.org/10.1364/AO.55.000B31.
2. Mokrinskaya E.V., Studzinsky S.L., Pavlov V.A., Chuprina N.G., Kravchenko V.V., Marinin A.I., Tonkopieva L.S., Davidenko I.I., Davidenko N.A. Photoconductivity of Film Composites Based on Branched Carbazolyl Oligomers with Different Numbers of Terminal Groups. // High Energy Chemistry, 2017, Vol. 51, No. 4, pp. 263–268. http://dx.doi.org/10.1134/S0018143917040117.
3. Davidenko N.A., Davidenko I.I., Pavlov V.A., Chuprina N.G., Tarasenko V.V., Studzinsky S.L. Adjustment of diffraction efficiency of polarization holograms in azobenzene polymers films using electric field. // J. Appl. Phys., 2017, v.122, p.013101-1 – 013101-6 (6p.). http://dx.doi.org/10.1063/1.4990995.
4. Davidenko N.A., Davidenko I.I., Mokrinskaya E.V., Pavlov V.A., Studzinsky S.L., Tarasenko V.V., Tonkopieva L.S., Chuprina N.G. Improved Diffraction Efficiency of Polarization-Sensitive Azobenzene-Containing Copolymers in an Electric Field. // J. Appl. Spectrosc., 2018, v. 85, N1, p. 154–160. https://doi.org/10.1007/s10812-018-0624-6.
5. Ovdenko V.N.,, Kolendo A.Yu., Mokrinskaya E.V., Pavlov V.A., Kravchenko V.V., Davidenko I.I., Davidenko N.A. A Recording Medium Based on Copolymer of 4-((1,5-Dimethyl-3-oxo-2-phenyl-2,3-dihydro-1H-pyrazol-4-yl)diazenyl)phenyl Methacrylate with Nonyl Methacrylate for Polarization Holography. // Polymer Science, Series B, 2018, Vol. 60, No. 4, pp. 464–468. https://doi.org/10.1134/S1560090418040097.
6. Davidenko N.A., Davidenko I.I., Mokrinskaya E.V., Chuprina N.G., Ishchenko A.A., Shemehen R.V., Milokhov D.S., Khilya O.V., Volovenko Yu.M. Photophysical Properties of a Composite Based on Polyepoxypropylpyridobenzothiazole with the Squarylium Dye. // J. Appl. Spectrosc., 2018, v.85, N5, p.870-875. https://doi.org/10.1007/s10812-018-0731-4.
7. Davidenko N.A., Davidenko I.I., Pavlov V.A., Chuprina N.G., Mokrinskaya E.V., Tarasenko V.V., Tonkopieva L.S., Kravchenko V.V. Recording medium based on the

films of azobenzene copolymer with free surface and in sandwich-structures for polarization holography. // Optical Materials, 2018, v.76, p.169-173. https://doi.org/10.1016/j.optmat.2017.12.027.
8. Davidenko N.A., Davidenko I.I., Pavlov V.A., Chuprina N.G., Kravchenko V.V., Tarasenko V.V., Studzinsky S.L., Mokrinskaya E.V., Tonkopieva L.S. Recording media for polarization holography with diffraction efficiency adjusted using electric field. // Optik, 2018, v. 158, p. 1308-1312. https://doi.org/10.1016/j.ijleo.2018.01.018.
9. Davidenko N.A., Davidenko I.I., Pavlov V.A., Chuprina N.G., Kravchenko V.V., Kuranda N.N., Mokrinskaya E.V., Studzinsky S.L. Photothermoplastic recording media and its application in the holographic method of determination of the refractive index of liquid objects. // Appl. Optics, 2018, v. 57, N 10, 6 p. https://doi.org/10.1364/AO.99.099999.
10. Vyshnevskyi D.G., Davidenko N.A., Davidenko I.I., Mokrinskaya E.V., Ovdenko V.N., Pavlov V.A. Effect of chromophore structure of azo dyes on their diffraction efficiency in polarization holograms of recording media. // Theoretical and Experimental Chemistry, 2018, v.54, N1, p.36-39). https://doi.org/10.1007/s11237-018-9542-1.
11. Davidenko N.A., Davidenko I.I., Pavlov V.A., Tarasenko V.V. Experimental investigations of the relaxation of polarizationholograms in films of azobenzene polymers withchromophores with different substitutes. // Optik, 2018, v.165, p.174–178. https://doi.org/10.1016/j.ijleo.2018.03.117.
12. Davidenko N.A., Davidenko I.I., Kravchenko V.V., Mokrinskaya E.V., Pavlov V.A., Tarasenko V.V. Recording Polarization Holograms in Films of 4-((2-Bromo-4-nitrophenyl)diazenyl)phenyl Methacrylate Copolymers. // Optics and Spectroscopy, 2019, v.126(2), p.135-139. https://doi.org/10.1134/S0030400X19020103.