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Европейския съюз
NextGenerationEU



BiOrgaMST
Биоактивни органични и неорганични
авангардни материали и чисти технологии



МИНИСТЕРСТВО
НА ОБРАЗОВАНИЕТО
И НАУКАТА

Група № 3.2.1: Фотоанизотропни материали за приложения в поляризационната холография и фотониката

Водещ изследовател: проф. д-р Лиан Неделчев



Годишна конференция по проект „BiOrgaMST“
5 декември 2023, ХТМУ – зала „Асен Златаров“

РП 1 Отлагане и характеризиране на слоеве от фотоанизотропни материали

- Приготвяне на образци от фоточувствителни органични материали, вкл. нови
- Определяне на спектри на пропускане и отражение на образците, механични свойства и др.
- Наблюдение на процеса на съхнене на оптичните слоеве; определяне на контактния ъгъл на разтвори на изследваните вещества

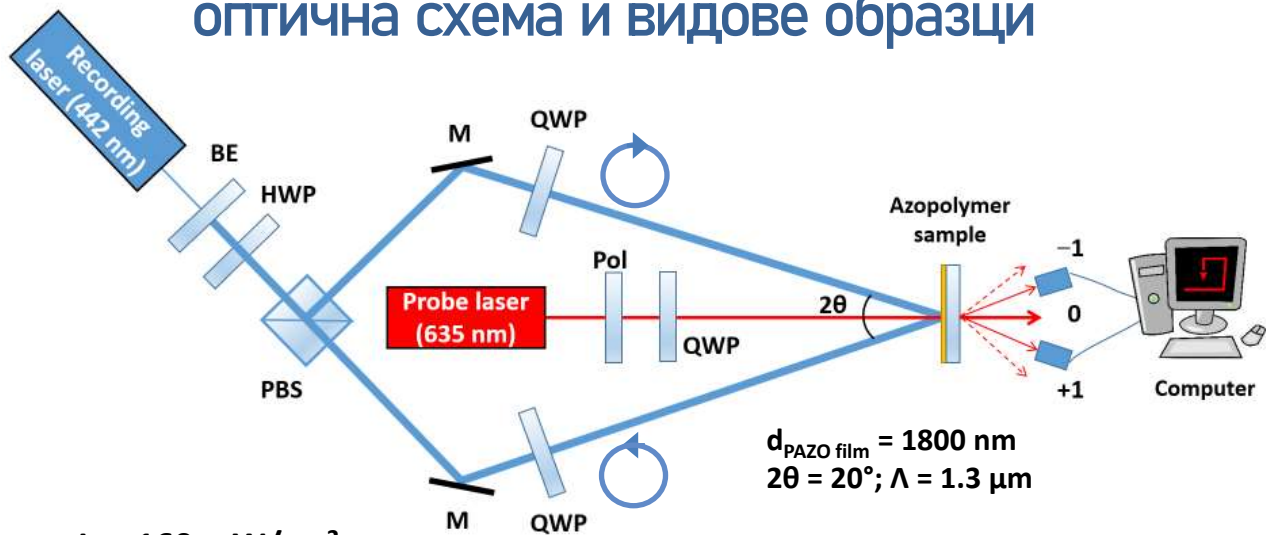
РП 2 Поляризационен холографски запис на дифракционни структури, обемни и повърхностни решетки

- Запис на поляризационни холографски решетки (PHG)
- Запис на 2D PHG и/или поляризационни холографски лещи (PHL)
- Изследване на фотоиндуцирани хирални структури

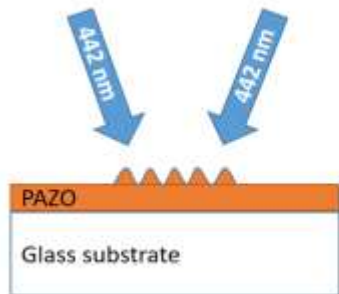
РП 3 Характеризиране на поляризационни холографски решетки за приложения във фотониката

- Поляриметричен анализ на поляризационна/скаларна решетка
- AFM изследване на повърхностни релефни решетки
- Метализиране на повърхностно релефни решетки за приложения във фотониката

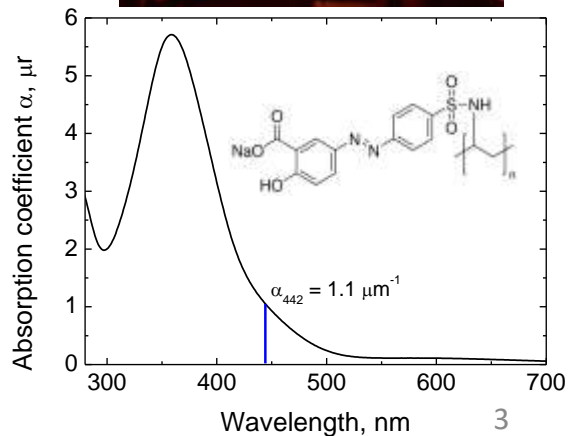
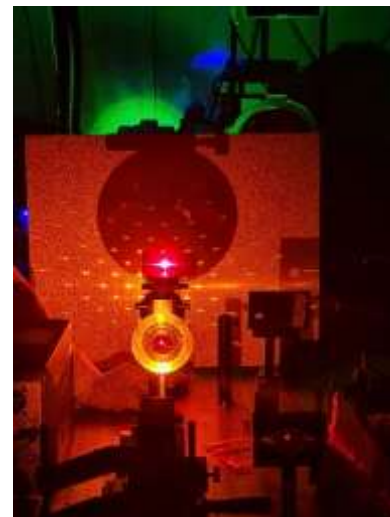
Запис на 2D холографски решетки със и без повърхностен релеф – оптична схема и видове образци



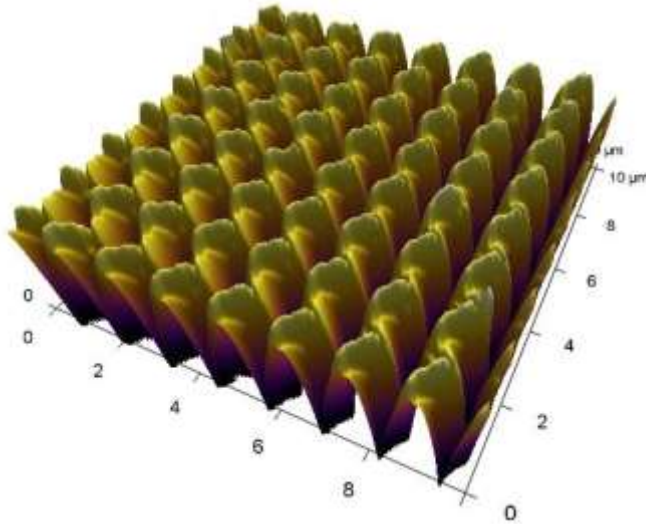
$$I_0 = 160 \text{ mW/cm}^2$$



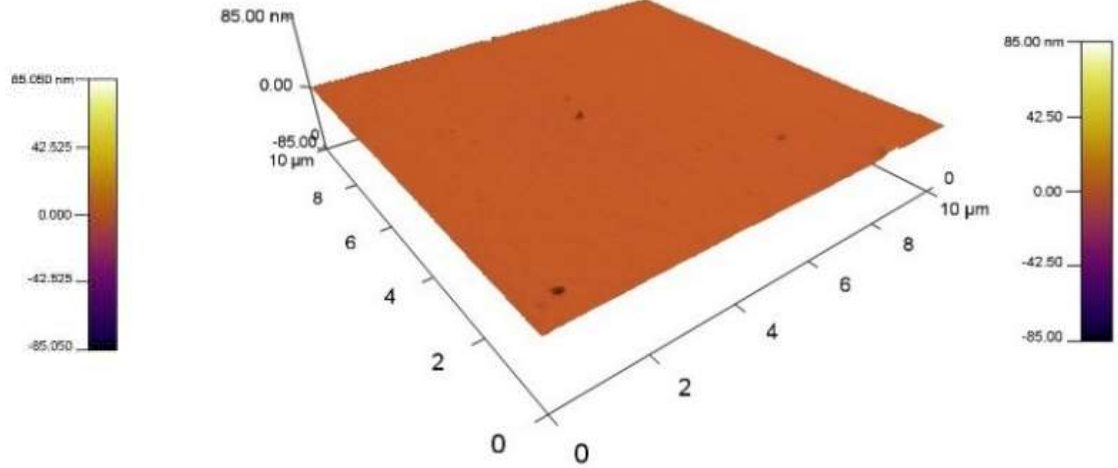
$$I \approx I_0/100$$



2D холографски решетки със и без повърхностен релеф – AFM анализ



case 1

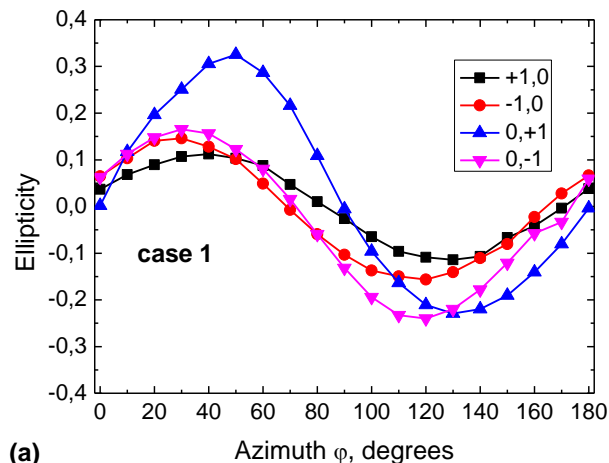


case 2

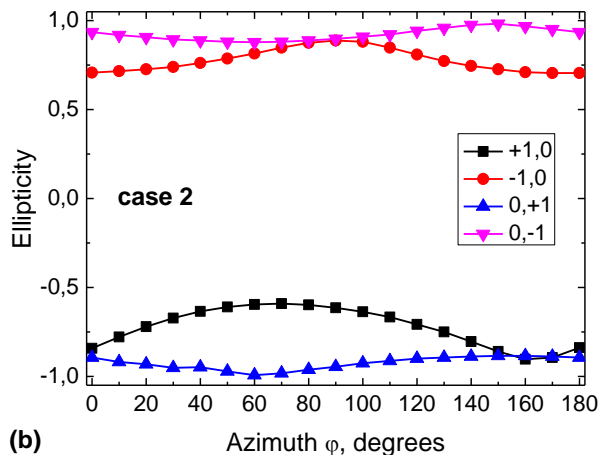
Mateev, G., Nedelchev, L., Nikolova, L., Ivanov, B., Strijkova, V., Stoykova, E., Choi, K., Park, J., Nazarova, D. Two-dimensional polarization holographic gratings in azopolymer thin films: Polarization properties in the presence or absence of surface relief. *Photonics* **10**, 728 (11 pp), 2023.

2D холографски решетки със и без повърхностен релеф – поляризационни свойства

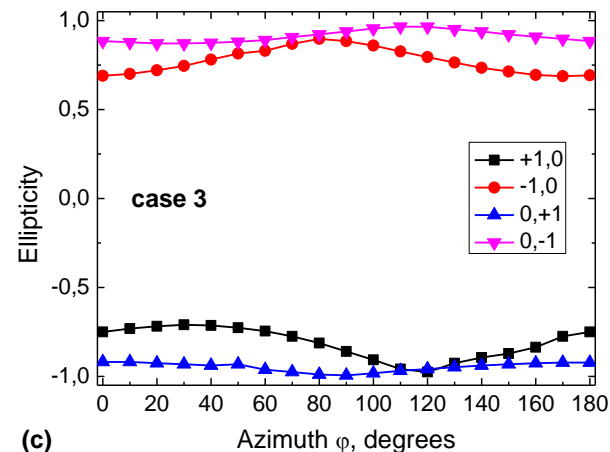
$e_{in} = 0$ (линейна поляризация); $\varphi = 0 \div 180^\circ$



доминират скалярните свойства
на повърхностната решетка

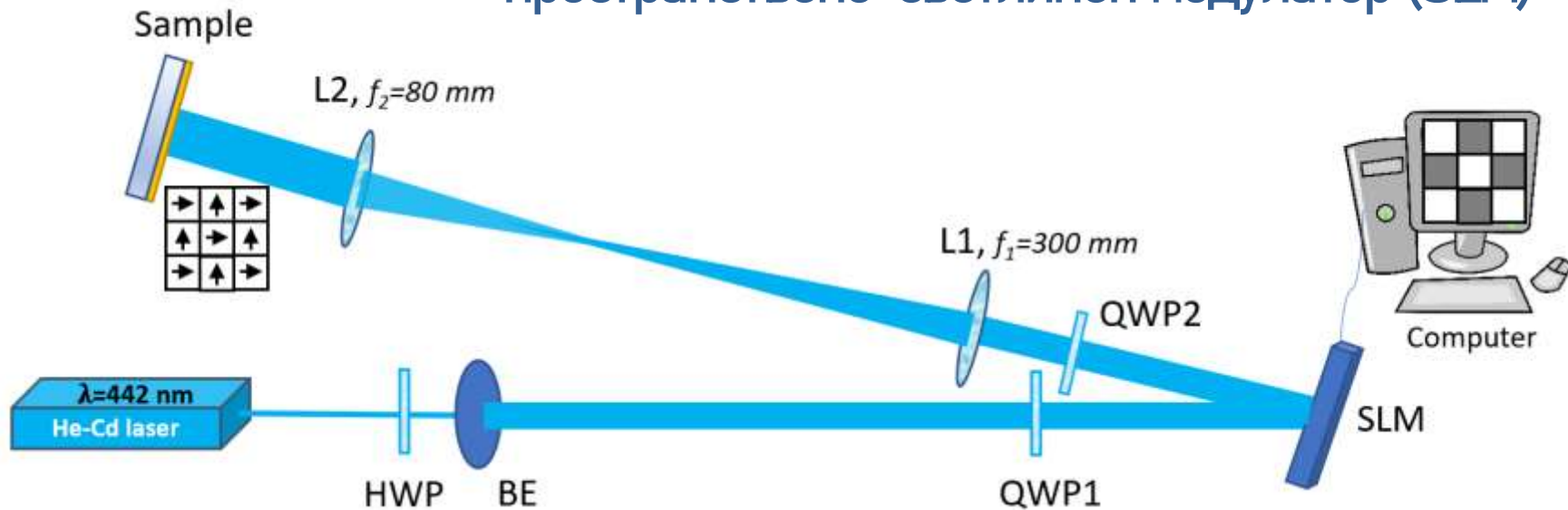


доминират поляризационните свойства
на обемната решетка



Mateev, G., Nedelchev, L., Nikolova, L., Ivanov, B., Strijkova, V., Stoykova, E., Choi, K., Park, J., Nazarova, D. Two-dimensional polarization holographic gratings in azopolymer thin films: Polarization properties in the presence or absence of surface relief. *Photonics* **10**, 728 (11 pp), 2023.

Цифрова поляризационна холография – оптична схема, използваща пространствено-светлинен модулатор (SLM)



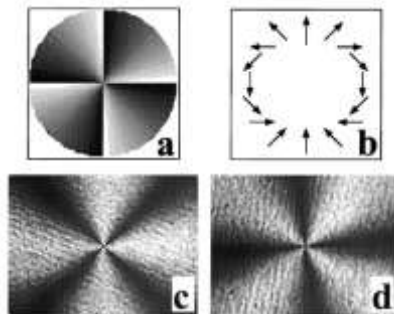
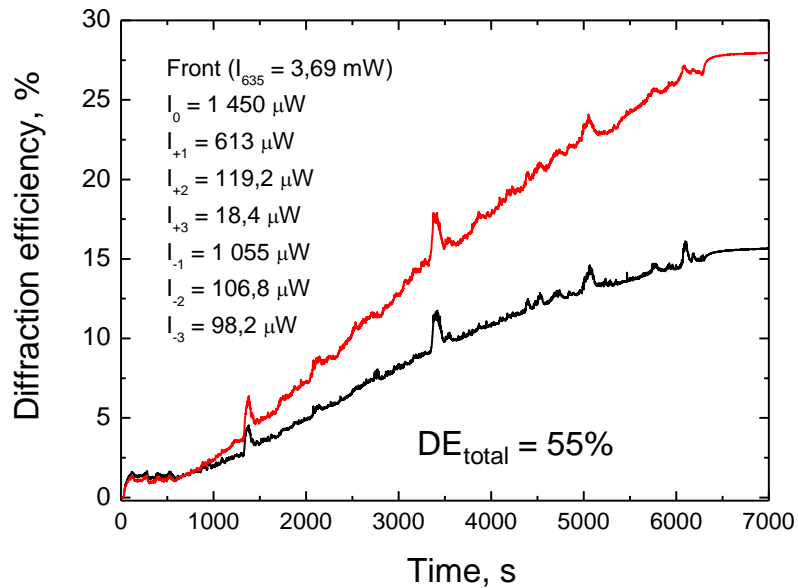
Spatial light modulator (SLM):

- Model: LETO-3 (HOLOEYE Photonics AG)
- Resolution: 1920 x 1080 pixels
- Pixel pitch: 6.4 μm
- Compact driver unit

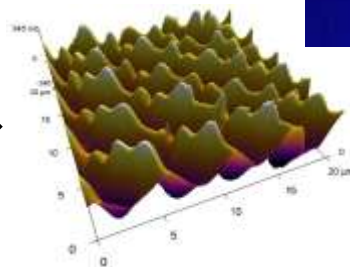
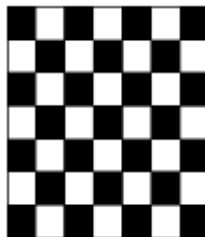
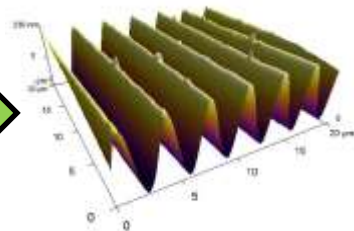
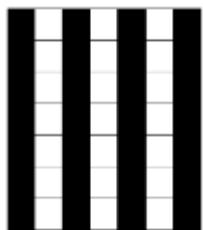
Предизвикателство: установена е промяна на фазовата разлика на SLM-а по време на експеримента поради загряване

Решение: темпериране на помещението, поставяне на радиатор за охлаждане на SLM-а

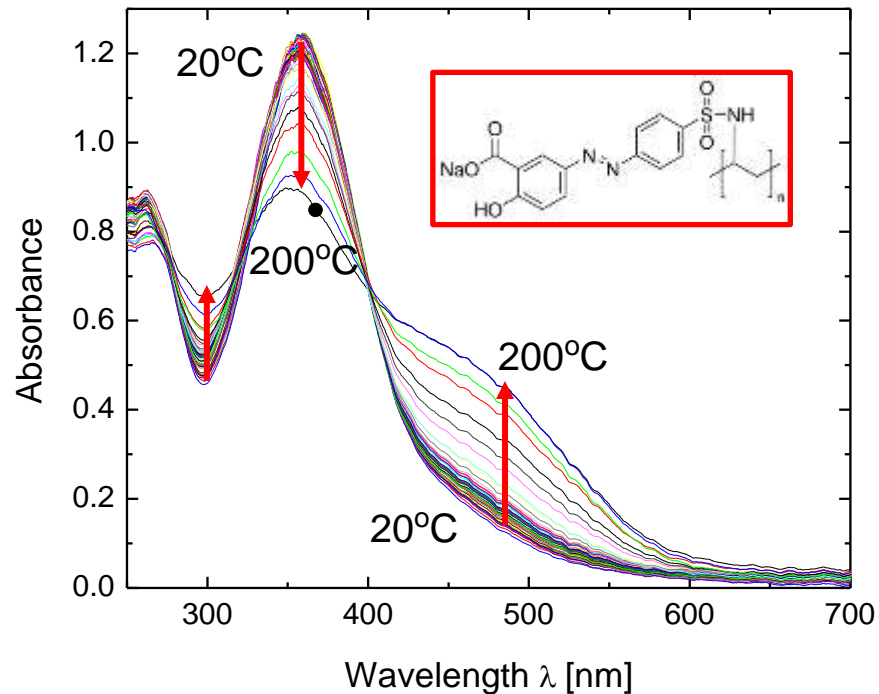
Цифрова поляризационна холография: кинетики на запис, AFM анализ



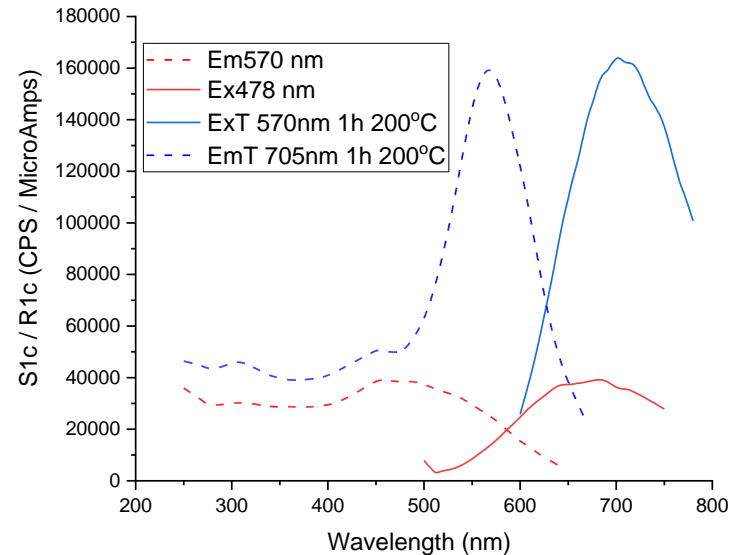
Предимства: чрез една експозиция могат да се получат 2D решетки, вкл. със сложна структура;
Ограничение: размера на пикселите на SLM-а;



Температурна зависимост на абсорбционните спектри на PAZO, флуориметричен анализ



Спектри на поглъщане на тънки слоеве от PAZO в зависимост от температурата на образца

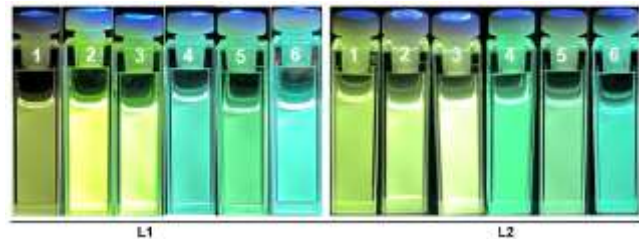
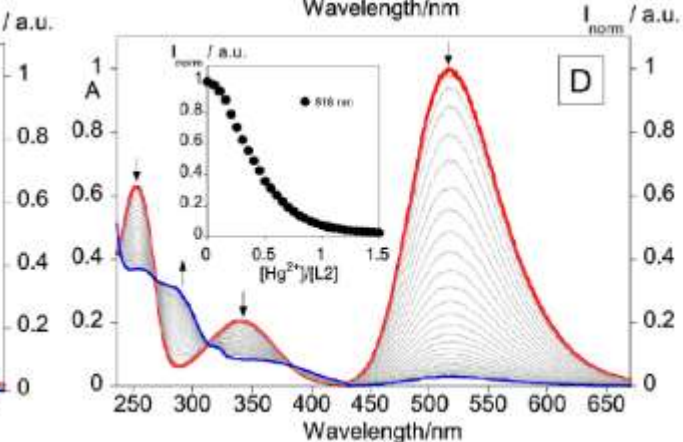
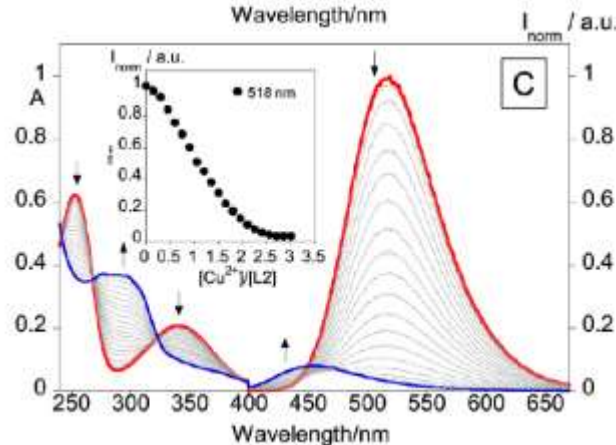
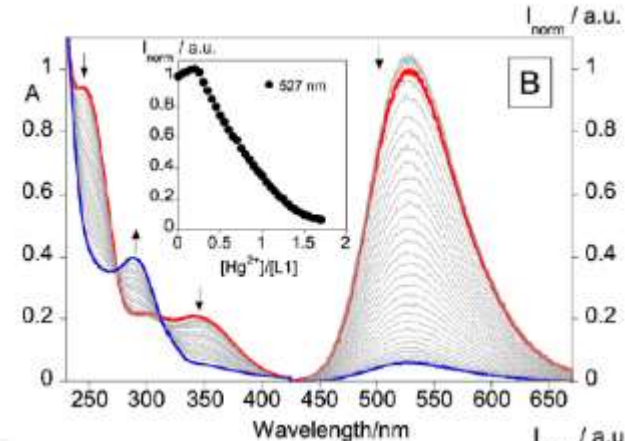
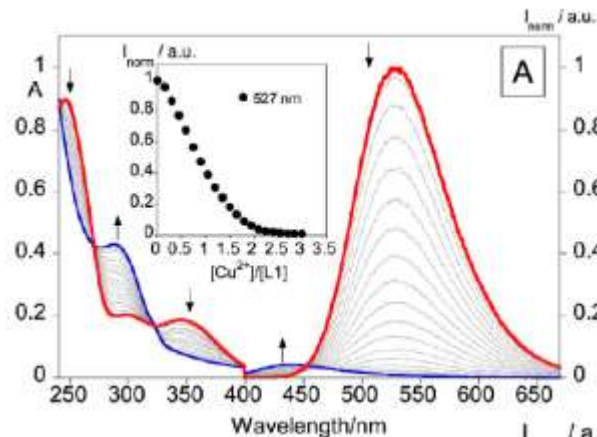
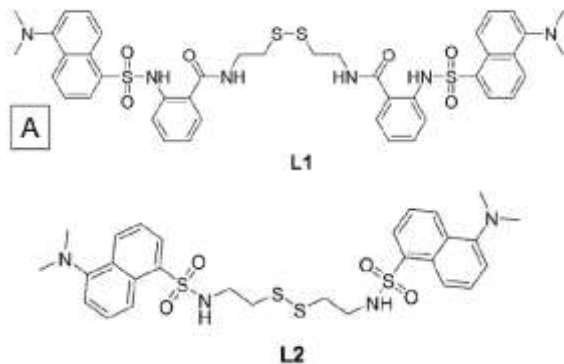


Флуоресцентни спектри на ПАЗО: слоеве при стайна температура и нагreti до 200°C.

Спектрите на емисия (Em) са снети при възбуждане (Ex) 478 nm и 570 nm за нагретите образци.

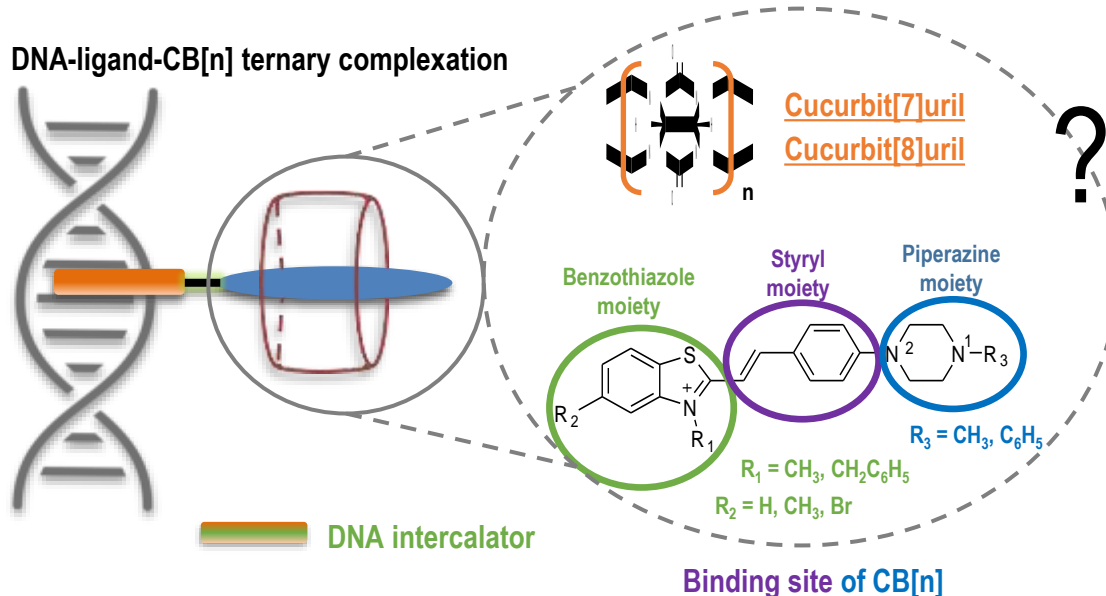
Спектри на възбуждане (Ex) са снети при емисия (Em) от 570 nm, а за нагретите слоеве – 705 nm.

Спектрофотометрични и спектрофлуориметрични изследвания на две данзилни производни



Dyes and Pigments **218**, 111428 (11 pp), 2023.
IF: 4.5 Q1

N-Methyl- and N-Phenylpiperazine Functionalized Styryl Dyes inside Cucurbiturils: Theoretical Assessment of the Factors Governing the Host-Guest Recognition



- ✓ С методите на изчислителната химия е изследвана термодинамиката на процесите на образуване на комплекси от типа домакин-гост на 12 багрила и две системи-домакини CB[7] и CB[8];
- ✓ Серията багрила с потенциално приложение като багрила за ДНК и тераностици е изследвана експериментално от Zonjić и съавтори [doi:10.1016/j.bioorg.2022.105999];
- ✓ Комплексообразуването на стироловите багрила с молекулите-домакини влияе положително на тяхното действие като ДНК интеркалатори и квадруплексни стабилизатори, повишава и флуоресцентния добив.

N. Kircheva, V. Petkova, S. Dobrev, V. Nikolova, **S. Angelova**, T. Dudev
molecules-2754732 (under review) **Q1, IF=4.6**

Обзорна статия за нанокompозитни фотоанизотропни материали



nanomaterials

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Nanocomposite Photoanisotropic Materials for Applications in Polarization Holography and Photonics

Dimana Nazarova; Lian Nedelchev; Nataliya Berberova-Buhova; Georgi Mateev

Nanomaterials 2023, Volume 13, Issue 22, 2946

Nazarova, D., Nedelchev, L., Berberova-Buhova, N., Mateev, G.

Nanocomposite photoanisotropic materials for applications in polarization

holography and photonics. *Nanomaterials* 13, 2946 (38 pp), 2023. IF: 5.3 Q1



Review

Nanocomposite Photoanisotropic Materials for Applications in Polarization Holography and Photonics

Dimana Nazarova ^{1,2}, Lian Nedelchev ^{1,2*}, Nataliya Berberova-Buhova ^{1,2} and Georgi Mateev ^{1,2}

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² Department of Physics, University of Chemical Technology and Metallurgy, 1756 Sofia, Bulgaria

* Correspondence: l.nedelchev@iam.oev.bg

Abstract: Photoanisotropic materials, in particular anisotropes and azopolymers, have attracted significant research interest in the last decades. This is due to their applications in polarization holography and 4G optics, enabling polarization-selective diffractive optical elements with unique properties, including circular polarization beam-splitters, polarization-selective bifocal lenses, and many others. Numerous methods have been applied to increase the photoinduced birefringence of these materials, and as a result, to obtain polarization holographic elements with a high diffraction efficiency. Recently, a new approach has emerged that has been extensively studied by many research groups, namely doping amberose-containing materials with nanoparticles with various compositions, sizes, and morphologies. The resulting nanocomposites have shown significant enhancement in their photoanisotropic response, including increased photoinduced birefringence, leading to a higher diffraction efficiency and a large surface relief modulation in the case of polarization holographic recordings. This review aims to cover the most important achievements in this new but fast-growing field of research and to present an extensive comparative analysis of the results, reported by many research groups during the last two decades. Different hypotheses to explain the mechanism of photoanisotropy enhancement in these nanocomposites are also discussed. Finally, we present our vision for the future development of this scientific field and outline its potential application in advanced photonics technologies.

Keywords: nanocomposite materials; nanoparticles; photoanisotropic materials; azopolymers; polarization holographic gratings; surface relief gratings

Dimana Nazarova, Lian Nedelchev, L., Berberova-Buhova, N., Mateev, G. Nanocomposite Photoanisotropic Materials for Applications in Polarization Holography and Photonics. *Nanomaterials* 2023, 13, 2946. <https://doi.org/10.3390/nano13222946>

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1. Introduction

The demand for new materials to develop modern technologies is constantly growing. Although nanocomposite (NC) materials have been in use for a long time, they are constantly being improved to enable increasingly advanced applications. The new materials, obtained by combining two or more materials on nanoscale level, in most cases not only combine the qualities of their components, but also yield new, advantageous properties. In many cases, the nanoparticles (NPs) incorporated in nanocomposite materials modify and improve the optical, mechanical, and electrical properties of the matrix.

The optical properties of nanocomposite materials have been used since ancient times. Stained glass windows and ancient works of art exemplify their applications. A popular example of the intriguing optical features of nanocomposites is the Lycurgus cup from the 4th century AD [1]. In this case, the basis is the effect obtained from the excitation of the surface plasmon resonance due to the presence of gold and silver nanoparticles in the glass, which is expressed in a change in the color of the cup depending on whether it is viewed in transmission or reflection.

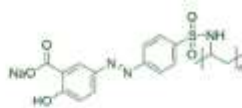
Обзорна статия за нанокompозитни фотоанизотропни материали

Разгледани са оптичните и фотоанизотропни свойства на широк набор от нанокompозитни материали, съдържащи азополимери и азобагрила с различен химичен състав, дотирани с метални или неметални наночастици. Обзорът е с обем **38** стр., обхваща **224** източника и се базира на **10-годишните** изследвания на нашата група върху този клас оптични материали.

Nazarova, D., Nedelchev, L., Berberova-Buhova, N., Mateev, G. Nanocomposite photoanisotropic materials for applications in polarization holography and photonics. *Nanomaterials* **13**, 2946 (38 pp), 2023.

PAZO

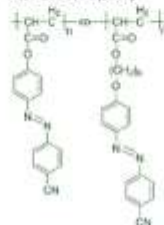
Berberova et al. (2016, 2017, 2021)
Nedelchev et al. (2021, 2013, 2016)
Falcone et al. (2021), Fernandez et al. (2015)
Mateev et al. (2019), Nazarova et al. (2019, 2021)
Stoilova et al. (2021)



P1 - Nedelchev et al. (2002), Nazarova et al. (2013)



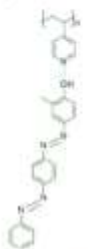
P3-2 - Nedelchev et al. (2002), Nazarova et al. (2013)



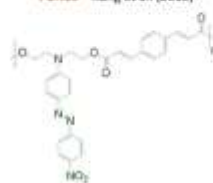
P2 - Nedelchev et al. (2002)



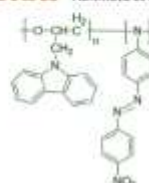
p4VP(DV7)1.0 Haultais et al. (2014)



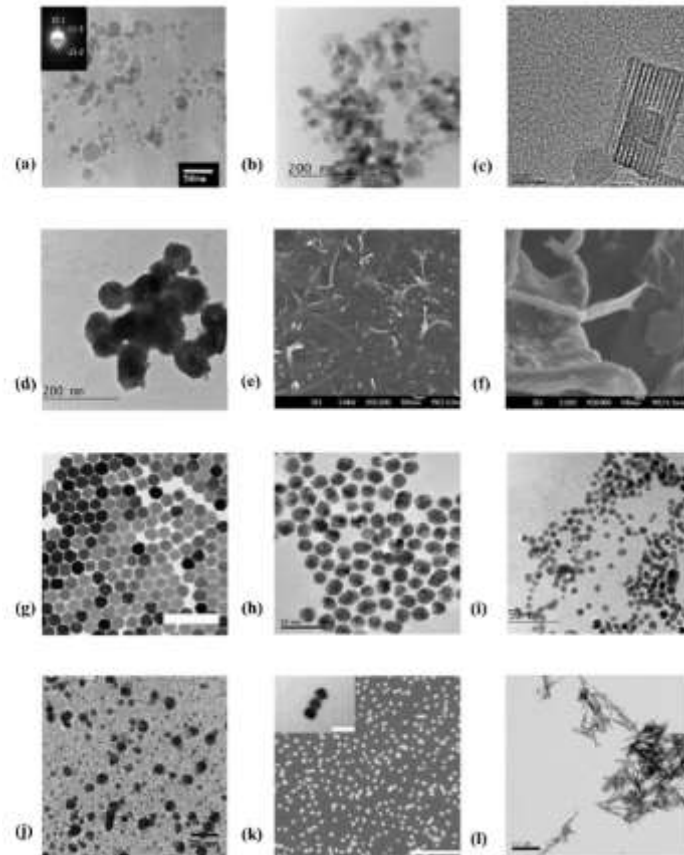
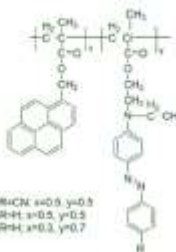
POR19 - Kang et al. (2018)



PEPC-co-DO - Achimova et al. (2019)



P1,P2,P3 - Vijayakumar et al. (2011)



Статии публикувани през 2023 година (1)

1. **G. Mateev, L. Nedelchev**, L. Nikolova, B. Ivanov, V. Strijkova, E. Stoykova, K. Choi, J. Park, **D. Nazarova**, [Two-dimensional polarization holographic gratings in azopolymer thin films: Polarization properties in the presence or absence of surface relief](#). *Photonics* **10**, 728 (11 pp), 2023. **IF: 2.536 Q2**
2. **D. Nazarova, L. Nedelchev, N. Berberova-Buhova, G. Mateev**, [Nanocomposite photoanisotropic materials for applications in polarization holography and photonics](#). *Nanomaterials* **13**, 2946 (38 pp), 2023. **IF: 5.3 Q1**
3. F. Duarte, G. Dobrikov, **A. Kurutos**, H. M. Santos, J. Fernandez-Lodeiro, J. L. Capelo-Martinez, E. Oliveira, C. Lodeiro, [Enhancing water sensing via aggregation-induced emission \(AIE\) and solvatofluorochromic studies using two new dansyl derivatives containing a disulfide bound: Pollutant metal ions detection and preparation of water-soluble fluorescent polymeric particles](#), *Dyes and Pigments* **218**, 111428 (11 pp), 2023. **IF: 4.5 Q1**
4. F. Duarte, G. Dobrikov, **A. Kurutos**, J. L. Capelo-Martinez, H. M. Santos, E. Oliveira, C. Lodeiro, [Development of fluorochromic polymer doped materials as platforms for temperature sensing using three dansyl derivatives bearing a sulfur bridge](#), *Journal of Photochemistry and Photobiology A: Chemistry* **445**, 115033 (13 pp), 2023. **IF: 4.3 Q2**
5. K. Anichina, **N. Georgiev**, N. Lumov, D. Vuchev, G. Popova-Daskalova, G. Momekov, E. Cherneva, R. Mihaylova, A. Mavrova, S. Atanasova-Vladimirova, I. Piroeva and **D. Yancheva**, [Fused Triazinobenzimidazoles Bearing Heterocyclic Moiety: Synthesis, Structure Investigations, and In Silico and In Vitro Biological Activity](#), *Molecules* **28**, 5034, 2023. **IF: 4.6 Q2**

Статии публикувани през 2023 година (2)

6. R. Smolka, **D. Yordanov**, K. Nakashima, M. Vala, J. Krajčovič, M. Weiter, **A. Georgiev**, [Control over rotary motion and multicolour switching in 3-hydroxyphthalimide fluorophores: An interplay between AIE and ESIPT](#), *Dyes and Pigments* **215**, 111279 (13 pp), 2023. **IF: 4.5 Q1**
7. **D. Yordanov**, R. Smolka, K. Nakashima, S. Hirashima, Y. Matsushima, M. Vala, J. Krajčovič, M. Weiter, Ts. Miura, and **A. Georgiev**, [Fluorescent Rotary Switches: Four- vs Three-Substituted Phthalimide Boron Difluoride Schiff Base Complexes](#), *Journal of Organic Chemistry* (Publication Date: November 21, 2023). **IF: 3.6 Q1**
8. **P. Miladinova**, *Advances in Materials Science Research*. Volume 67, Maryann C. Wythers (Editor), Chapter 3. [Triazines and Their Applications](#), Publication Date: December 2023, Status: In Production, Nova Science Publishers, New York, ISBN: 979-8-89113-329-7
9. D. Stratiev, **V. Toteva**, I. Shishkova, S. Nenov, D. Pilev, K. Atanassov, V. Bureva, S. Vasilev and D. Stratiev, [Industrial Investigation of the Combined Action of Vacuum Residue Hydrocracking and Vacuum Gas Oil Catalytic Cracking While Processing Different Feeds and Operating under Distinct Conditions](#), *Processes* **11**, 3174 (26 pp), 2023. **IF: 3.5 Q2**

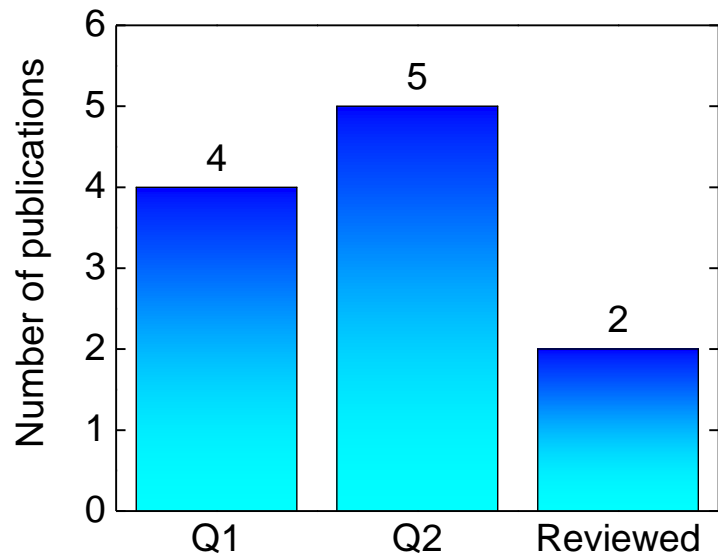
Статии приети за публикуване през 2023 година

1. D. Staneva, **D. Atanasova**, I. Grabchev, [Fluorescent composite cotton fabric modified with crosslinked chitosan for theranostic applications](#), *Applied Sciences* (accepted on 23.11.2023). **IF: 2.7 Q2**
2. M. Koleva, D. Angelova, **D. Zheleva**, [Methods for the synthesis of TiO₂ nanoparticles. Properties of textile materials treated with TiO₂ nanoparticles](#), *Journal of Chemical Technology and Metallurgy* (accepted on 20.11.2023)

Статии изпратени за публикуване през 2023 година

1. S. Stoyanov, K. Anichina, B. Ivanova, S. Georgieva, **D. Yancheva** and B. Stamboliyska, [Conversion of 1-alkylated 5\(6\)-nitro-1H-benzimidazoles into radical anion species with potential for development of bioreductive agents](#) (submitted to *Molecules* **IF: 4.6 Q2**)
2. **P. Miladinova**, D. Todorova, [Synthesis and Application of New Homobifunctional Reactive Triazine Dyes Containing UV Absorber](#) (submitted to *Fibers and Polymers* **IF: 2.5 Q2**)
3. N. Kircheva, V. Petkova, S. Dobrev, V. Nikolova, **S. Angelova**, T. Dudev, [N-Methyl- and N-Phenylpiperazine Functionalized Styryl Dyes inside Cucurbiturils: Theoretical Assessment of the Factors Governing the Host-Guest Recognition](#) (submitted to *Molecules* **IF: 4.6 Q2**)

Статии – публикувани и приети за публикуване през 2023 година



Индексирани в Web of Science, квартал **Q1**: 4

Индексирани в Web of Science, квартал **Q2**: 5

Неиндексирани в Web of Science: 2

Общо: 11

Със съавтори от други групи на проекта: 3

Участия в научни форуми по тематиката на проекта през 2023 (1)

1. **L. Nedelchev**. [Polarization holography: Principles, Materials and Applications](#) (По покана), Webinar of Holography and Diffractive Optics Technical Group - OPTICA, 29.03.2023, Online
2. **Неделчев, Л.** [Фотоанизотропни материали с приложения за поляризационна холография](#) (По покана), XVI-ти Пролетен семинар на докторантите и младите учени “Интердисциплинарна химия”, 24-25.04.2023, София, България
3. **Nedelchev, L.** [Polarized Light: Applications for Polarization Holography and Polarimetry](#) (По покана), LIGHT for LIFE Seminar 2023: Light-Based Processes and Technologies for a Sustainable Future, 16.05.2023, Sofia, Bulgaria
4. **A. Kurutos**, [Biocompatible Fluorescent Probes Emitting in the Visible, Near-Infrared Region, and Beyond: From Small Molecules to Supramolecular Assemblies](#), 1st Autumn workshop on functional organic materials for sustainable future, 15–16 November 2023, Brno
5. **D. Atanasova**, D. Staneva, I. Grabchev, [Textile-Hydrogel Composite Material-Anti-Inflammatory Agent with Potential Application as a Wound Dressing](#), XXV National Textile Conference NTC 2023, 26-28 October 2023, Blagoevgrad, Bulgaria

Участия в научни форуми по тематиката на проекта през 2023 (2)

6. **D. Zheleva**, D. Angelova, M.Koleva, E.Vasileva-Tonkova, [Investigation of the antibacterial activity of gelatin-modified textile materials with incorporated metal nanoparticles](#), Global Conference on Research in Chemistry and Chemical Engineering, 8-9 December 2023, Berlin, Germany
7. **P. Miladinova**, **D. Fachikova**, [Synthesis, dyeing ability and photostability of new reactive triazine dyes](#), 6-th International Conference on Materials Science and Nanotechnology, 06-07 September 2023, Rome, Italy
8. **D. Fachikova**, **P. Miladinova**, G. Ilieva, [A comparative study of calcium phosphate coatings for biomedical applications](#), 6-th International Conference on Materials Science and Nanotechnology, 06-07 September 2023, Rome, Italy
9. **P. Miladinova**, P. Najdenova-Marinova, [The Synthesis and Photostability of Some New 1,8-Naphthalimide Derivative for Fluorescent Polymers](#), 26th Congress of SCTM, 20-23 September 2023, Ohrid, N. Macedonia
10. **V. Toteva**, G. Georgiev, D. Angelova, N. Yotova, [Processing of Waste Cotton to Glucose and Valuable Chemicals \(Hydroxymethylfurfural\)](#), XXV National Textile Conference NTC 2023, 26-28 October 2023, Blagoevgrad, Bulgaria

Участия в научни форуми по тематиката на проекта през 2023



Global Conference on Research in Chemistry and Chemical Engineering

Berlin, Germany

Dear Dr. Darina Zheleva,

Congratulations! We are pleased to inform you that your research on the antibacterial activity of gelatin has been accepted for presentation at the Global Conference on Research in Chemistry and Chemical Engineering, Berlin, Germany, in December 2023.

Innovinc

CERTIFICATE OF ATTENDANCE

Innovinc International
Members of

Dr. Darina Zheleva, *Polya M...*

University of Chemical Technology

for her phenomenal contribution to the field of
Synthesis, dyeing ability and pH sensitivity of
at the "6th International Conference on
MATERIALS SCIENCE AND CHEMISTRY"
held during September 2023.

Prof. Gion Calzaferri
Prof. Gion Calzaferri
University of Bern, Switzerland



SOCIETY OF CHEMISTS AND TECHNOLOGISTS OF MACEDONIA (SCTM)

CERTIFICATE OF ATTENDANCE

Hereby we certify that the **poster presentation** titled:

Derivative for

23 September

Dr. Brijana Angjusheva
Organizing Committee, President



Участия в научни форуми през 2023

29 March 2023 10:00 - 11:00
Eastern Time (US & Canada) (UTC - 05:00)

Polarization Holography: Principles, Materials and Applications
In this webinar, Lian Nedelchev will discuss some important characteristics of the polarization-sensitive materials.

Share

OPTICA Technical Society

Featuring Lian Nedelchev from the Institute of Optical Materials and Technologies - Bulgarian Academy of Sciences

29 March 2023

OPTICA Formerly **OSA**

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IBPhBME

LIGHT for LIFE Seminar Series 2023

LIGHT-BASED PROCESSES AND TECHNOLOGIES FOR SUSTAINABLE FUTURE
Sofia, Bulgaria, Bulgarian Academy of Sciences
Acad. G Bonchev Str. Bl. 21, floor 2, 16.05.2023, 13 – 17.30 h

Organizers:

- Institute of Biophysics and Biomedical Engineering
- Institute of Plant Physiology and Genetics

Main topics:

- Light-induced biological processes
- Light sources in life sciences, biomedicine and nanotechnology
- Advanced communication and optical technologies

Invited speakers:

- Prof. Lian Nedelchev – Institute of Optical Materials and Technologies "Acad. Jordan Malinowski", Bulgarian Academy of Sciences
- Prof. Natalia Krasteva – Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences
- Assoc. Prof. Kiril Mishev – Institute of Plant Physiology and Genetics, Bulgarian Academy of Sciences

<https://biomed.bas.bg/and/light-for-life-2023/>

https://www.optica.org/events/webinar/2023/03_march/polarization_holography_principles_materials_and_a/

Регистрираните участници в уебинара са над 200 души от целия свят. Уебинарът премина при изключителен интерес, с над 15 зададени въпроса от участниците. Пълният видеозапис на лекцията е достъпен на сайта на престижната организация OPTICA (formerly Optical Society of America – OSA).

Международно сътрудничество



Prof. Izabela Naydenova

Scientific Director & Principal Investigator

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👤 [Profile](#)

Посещението на **Prof. Izabela Naydenova** бе осъществено в периода 27.06.2023 г. до 23.07.2023 г. в рамките на договор по проект BiOrgaMCT.

Осъществени са и контакти с:

- **Prof. Pablo Sanchis Kilders, Dr. Ana Díaz Rubio** (Nanophotonics Technology Center, Polytechnical University of Valencia);
- **Prof. Ivan Divliansky**, University of Central Florida, CREOL (Chair of Holography and Diffractive Optics TG, OPTICA)



Благодарности

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МИНИСТЕРСТВО
НА ОБРАЗОВАНИЕТО
И НАУКАТА



Финансирано от
Европейския съюз
NextGenerationEU



Химикотехнологичен
и металургичен
университет

Благодаря Ви за вниманието!

