DOCTORAL STUDIES COURSE UNIT DESCRIPTION

Name of subject	Scientific Field	Faculty	Center/Institute/ Department
Electronic Processes in Organic Solids (8 ECTS credits)	Physics N 002	Faculty of Physics	Institute of Photonics and Nanotechnology
Student's workload	Hours	Student's workload	Hours
Lectures	30	Consultations	
Individual study	160	Seminars	10

Course annotation

Introduction. Organic materials for electronics - Challenges and Perspectives. Progress in Organic Technologies. Organic optoelectronic device market.
Excited states in Molecules and molecular complexes. Electronic and vibronic transitions in pi-conjugated molecules. Evolution of the excited states. Nonradiative transitions. Solvation phenomena. Intermolecular complexes. Excitation quenching processes. Photoreaction of organic molecules. Energy transport phenomena.
Excited states of organic crystal. Excitons. Davydov exciton band. Singlet excitons. Exciton polaritons. Vibronic and phonon crystalline states. Exciton-phonon coupling self-trapped excitons. Triplet excitons. Energy transfer in molecular systems. Energy migration in disordered materials. Exciton recombination. Exciton annihilation.
Charge carriers in organic solids. Ionized molecular and crystal states. Polaron species. Modified Laions diagram. Carrier generation and recombination. Charge separation phenomena. Charge carrier mobility dependence on temperature and electric field. Electron transport in molecular structures, band model and hopping. Organic crystal defect states.
Excited states in polymers. Conformations of macromolecules. Amorphous and crystalline polymers. Polymer solutions. Polymeric dielectric material. Polymeric photoconductors. Mixed polymers. Polymers with multifunctional fragments. Natural polymers.
New molecular systems. Carrier transport materials. Singlet and Triplet and TADF emitting material. Charge separation complexes. Functionalization of multifragment molecular systems. Hybrid Systems.
Progress in organic devices. Photosensitive semiconductor systems, Xerography and photovoltaics. Organic light-emitting diodes and lasers. OLED displays and general lighting. Organic transistors and plastic chips. Organic sensors.

List of literature

1. A.Kohler and H.Bassler, Electronic Processes in Organic Semiconductors, Weinheim, Germany, Wiley-VCH, 2015.
2. Ed.: W.Hu, Organic Optoelectronics, Weinheim, Germany, Wiley-VCH, 2013
3. M.Pope, C.E.Svenberg, Electronic Processes in Organic Crystals N.Y.: Oxford Univ. Press, 1999.
4. Ed. W.Brutting, Ch.Adachi, Physics of Organic Semiconductors, Weinheim, Germany, Wiley-VCH, 2012
5. B.D.Malhotra Hanbook of Polymers in Electronics, Shawbury: RAPRA Technology LTD, 2002
6. S. Juršėnas. Organinės optoelektronikos prietaisai. Vilniaus universitetas, 2008.
7. Ron Mertens, The OLED Handbook, Ron Mertens, 2016

List of additional literature

1. S. Juršėnas. Organiniai puslaidininkiai. Vilniaus universitetas, 2008 2. V.Gulbinas, Šviesos sukelti molekuliniai vyksmai ir jų lazerinė spektroskopija. Vilnius: TEV, 2008. 3. N. Karl, Charge Cartier mobility in Organic Crystals, in R. Farchioni, G. Grosso (Eds.), Organic Electronic Materials, Springer, 2001. 4. W.Tress, Organic Solar Cells, V.208, Heidelberg, Springer, 2014 5. N. Karl, Charge Cartier mobility in Organic Crystals, in R. Farchioni, G. Grosso (Eds.), Organic Electronic Materials, Springer, 2001.			
Consulting teachers	Scientific degree	Pedagogical name	Main scientific works published in a scientific field in last 5 year period
Saulius Juršėnas	habil. Dr.	Prof.	1. P. Baronas, G. Kreiza, P. Adomėnas, O. Adomėnienė, K. Kazlauskas, J.-Ch. Ribierre, Ch. Adachi, and S Jursenas, "Low-Threshold Light Amplification in Bifluorene Single Crystals: Role of the Trap States", ACS Applied Materials & Interfaces (2018) 10, 2768-2775. 2. P Scajev, R Aleksiejunas, S Miasojedovas, S Nargelas, M Inoue, C Qin, T. Matsushima, Ch. Adachi, and S. Juršėnas,“Two Regimes of Carrier Diffusion in Vapor-Deposited Lead-Halide Perovskites“, J. Phys. Chem. C, 121 (39), 21600–21609 (2017). 3. P. Ščajev, Ch. Qin, R. Aleksiejūnas, P. Baronas, S. Miasojedovas, T. Fujihara, T. Matsushima, Ch. Adachi, and S. Juršėnas, „Diffusion Enhancement in Highly Excited MAPbI3 Perovskite Layers with Additives“, J. Phys. Chem. Lett. (2018) 9, 3167−3172. 4. S. Raišys, S. Juršėnas, Y. Simon, Ch. Weder, K. Kazlauskas, Enhancement of triplet-sensitized upconversion in rigid polymers via singlet exciton sink approach, Chemical Science, 9, 6796-6802 (2018) 5. T. Serevičius, R.Skaisgiris, J. Dadonova, J. Bucevičius, L. Ignatavičius, K. Kazlauskas, S. Jursenas and S. Tumkevicius, „Emission wavelength dependence on rISC rate in TADF compounds with large conformational disorder“, ChemComm (2019) 55, 1975-1978 6. P. Scajev, Dž. Litvinas, V. Soriūtė, G. Kreiza, S. Stanionytė, S. Juršėnas „Crystal Structure Ideality Impact on Bimolecular, Auger, and Diffusion Coefficients in Mixed-Cation CsxMA1–xPbBr3 and CsxFA1–xPbBr3 Perovskites“, The Journal of Physical Chemistry C (2019), 123, 39, 23838-23844

			7. P. Ščajev, R. Aleksiejūnas, P. Baronas, Dž. Litvinas, M. Kolenda, Ch. Qin, T. Fujihara, T. Matsushima, Ch. Adachi, S. Juršėnas, „Carrier Recombination and Diffusion in Wet-Cast Tin Iodide Perovskite Layers Under High Intensity Photoexcitation", The Journal of Physical Chemistry C (2019), 123, 32, 19275-19281. 8. R. Skaisgiris, T. Serevičius, K. Kazlauskas, Y. Geng, Ch. Adachi, S. Juršėnas, „Origin of dual emission in σ-bridged donor–acceptor TADF compounds", Journal of Materials Chemistry C (2019), 7, 40, 12601-12609 9. P. Scajev, R. Aleksiejunas, Sh. Terakawa, Ch. Qin, T. Fujihara, T. Matsushima, Ch. Adachi, S. Jursenas, „Anisotropy of Thermal Diffusivity in Lead Halide Perovskite Layers Revealed by Thermal Grating Technique", The Journal of Physical Chemistry C (2019), 123, 24, 14914-14920. 10. P. Baronas, G. Kreiza, M. Mamada, S. Maedera, P. Adomėnas, O. Adomėnienė, K. Kazlauskas, C. Adachi, S. Juršėnas; „Enhanced Energy Transfer in Doped Bifluorene Single Crystals: Prospects for Organic Lasers"; Advanced Optical Materials; (2020), 8, 4, 1901670. 11. P. Scajev, S. Miasojedovas, S. Jursenas; „Carrier density dependent diffusion coefficient, recombination rate and diffusion length in MAPbI 3 and MAPbBr 3 crystals measured under one-and two-photon excitations"; Journal of Materials Chemistry C, (2020) DOI: 10.1039/D0TC02283G 12. G. Kreiza, D. Banevičius, J. Jovaišaitė, S. Juršėnas, T. Javorskis, V. Vaitkevičius, E. Orentas, K. Kazlauskas; „Realization of deep-blue TADF in sterically controlled naphthyridines for vacuum-and solution-processed OLEDs", Journal of Materials Chemistry C, (2020). 13. E. Radiunas, S. Raišys, S. Juršėnas, A. Jozeliūnaitė, T. Javorskis, U. Šinkevičiūtė, E. Orentas, K. Kazlauskas, „Understanding the limitations of NIR-to-visible photon upconversion in phthalocyanine-sensitized rubrene systems", Journal of Materials Chemistry C (2020) 8,16, 5525-5534.

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<tr><td></td><td></td><td></td><td>14. T. Serevičius, J. Dodonova, R. Skaisgiris, D. Banevičius, K. Kazlauskas, S. Jursenas, S. Tumkevicius, “Optimization of carbazole-pyrimidine linking pattern for achieving efficient TADF” Journal of Materials Chemistry C (2020) DOI: 10.1039/D0TC02194F.
15. T. Serevičius, R. Skaisgiris, J. Dodonova, L. Jagintavičius, D. Banevičius, K. Kazlauskas, S. Tumkevičius, S. Juršėnas; „Achieving Submicrosecond Thermally Activated Delayed Fluorescence Lifetime and Highly Efficient Electroluminescence by Fine-Tuning of the Phenoxazine–Pyrimidine Structure“; ACS Applied Materials & Interfaces, (2020), 12, 9, 10727-10736.</td></tr>
<tr><td colspan="4">Certified during Doctoral Committee session 02/02/2022, protocol No. (7.17 E) 15600-KT-32</td></tr>
<tr><td colspan="4">Committee Chairman prof. S. Juršėnas</td></tr>
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