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ВПЛИВ ЗОВНІШНЬОГО ЕЛЕКТРИЧНОГО ПОЛЯ ТА ОДНОВІСНОГО ТИСКУ НА ДІЕЛЕКТРИЧНІ ВЛАСТИВОСТІ КРИСТАЛІВ TGS+Cu²⁺

Наведено результати експериментального дослідження впливу одновісного тиску та зовнішнього електричного поля на діелектричні властивості кристалів ТГС, легованих металічними домішками Cu²⁺, в околі структурного сегнетоелектричного фазового переходу. Отримані результати порівнюються з літературними даними для нелегованого домішками кристалу ТГС. Результати експериментальних вимірювань показали, що для кристалів ТГС+Cu²⁺ одновісний тиск σ_2 приводить до зменшення максимальних значень діелектричної проникності та зменшення температури фазового переходу, а зовнішнє електричне поле призводить до зменшення максимального значення діелектричної проникності і зростання температури фазового переходу.

Ключові слова: ТГС, зовнішнє електричне поле, одновісний тиск, металічні домішки, діелектрична проникність, сегнетоелектрики.

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ВЛИЯНИЕ ВНЕШНЕГО ЭЛЕКТРИЧЕСКОГО ПОЛЯ И ОДНООСНОГО ДАВЛЕНИЯ НА ДИЭЛЕКТРИЧЕСКИЕ СВОЙСТВА КРИСТАЛЛОВ TGS+Cu²⁺

Приведены результаты экспериментального исследования влияния одноосного давления и внешнего электрического поля на диэлектрические свойства кристаллов ТГС, легированных металлическими примесями Cu²⁺, в окрестности структурного сегнетоэлектрического фазового перехода. Полученные результаты сравниваются с литературными данными для нелегированного примесями кристалла ТГС. Результаты экспериментальных измерений показали, что для кристаллов ТГС+Cu²⁺ одноосное давление σ_2 приводит к уменьшению максимальных значений диэлектрической проницаемости и уменьшению температуры фазового перехода, а внешнее электрическое поле приводит к уменьшению максимального значения диэлектрической проницаемости и увеличению температуры фазового перехода.

Ключевые слова: ТГС, внешнее электрическое поле, одноосное давление, металлические примеси, диэлектрическая проницаемость, сегнетоэлектрики.

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LUMINESCENT PROPERTIES OF ORGANIC DYES IN POLYMERS PEPK AND PVE

Sandwich-structures for the electroluminescence investigation were produced with the method of the organic dye applying to the glass substrate surface covered with ITO with spin-coating. Aluminium contacts were evaporated in the vacuum chamber. Samples for the photoluminescence investigation were produced simultaneously. The dependence of the change in position of the maxima of the photoluminescence spectra on the dye content and the matrix polymer type were investigated. Current-voltage characteristic of the produced structures were obtained and the dependence of integral electroluminescence intensity on the voltage on the sample was determined.

Key words: organic dye, PEPK, PVE, ITO, sandwich-structure, OLED, photoluminescence, electroluminescence, PPV.

Light emitting structures based on organic materials are widely used all over the world. In comparing to liquid crystal displays (LCD) OLED-displays need any external highlight, have a large viewing angle and wide working temperature range. OLED-technologies permit flexible displays creation. One of the fundamental materials for organic light emitting structure fabrication is PPV. The aim of this work is investigation of polymers PEPK and PVE, doped with an organic dye, as an alternative material for organic light emitting structures fabrication.

Samples for the electroluminescence investigation were made as a sandwich-structure (Fig. 1). On the glass substrate with ITO-layer sequentially were applied layers of PEDOT:PSS and polymer, doped with an organic dye using spin coating [2]. Chosen PEDOT:PSS is modified and has optimal conductivity and capacity [3]. PEDOT:PSS decreases ITO surface irregularity and enhance hole injection [4].

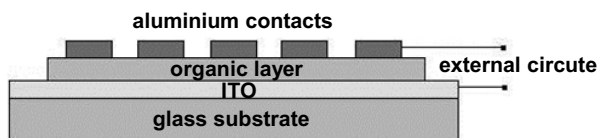


Fig. 1. Sandwich-structure

As an active layer we used polymers PEPK and PVE, doped with the organic dye DCM (1% and 10%). Structural formulas of the dyes DCM and №1 are shown on figures 2

and 3 respectively. Aluminium electrodes were deposited through the mask on the polymer layer.

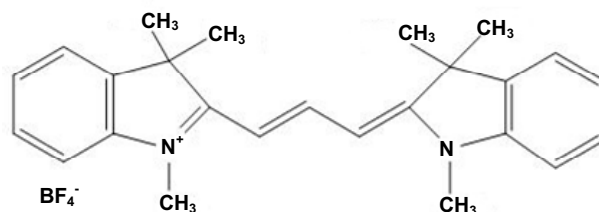


Fig. 2. Structural formula of the dye №1

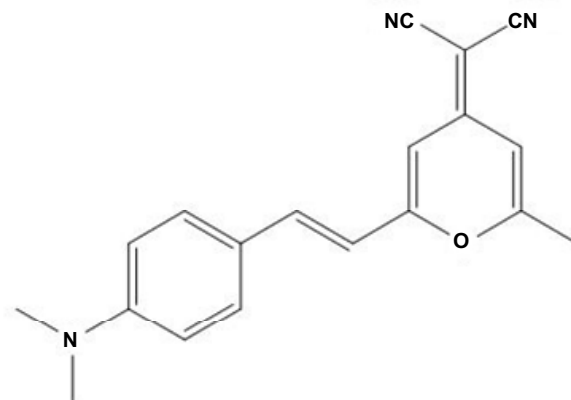


Fig. 3. Structural formula of the dye DCM

Simultaneously samples for photoluminescence investigation were created. To fabricate them the same solutions of the polymers, doped with organic dyes, were deposited on the glass substrate by coating.

Electrophysical and luminescent characteristics investigation of the samples was conducted on an automated installation, based on the aperture of the monochromator MDR-2 [1].

Photoluminescence spectra of investigated samples with DCM are shown on figure 4. Photoluminescence spectra depend on polymer type and dye concentration. The maximum intensity of photoluminescence when using 10% doping shifts toward the long-wave region compared to the photoluminescence maximum at 1% doping. ($\lambda = 40\text{nm}$).

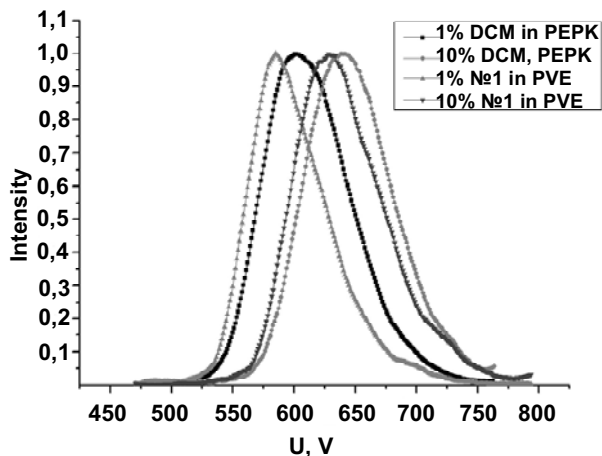


Fig. 4. Photoluminescence spectrum of 1% and 10% DCM in PEPK and PVE

Photoluminescence spectra of samples with the dye №1 are shown on the figure 5. Photoluminescence maxima sequence of the samples with the dye №1 is similar to the photoluminescence maximum sequence of the samples with the dye DCM. The maximum of the photoluminescence of the sample based on PVE with 1% organic dye concentration ($\lambda = 610\text{ nm}$) is located in the most shortwave region. Further is located the photoluminescence maximum of the sample based on PEPK with 1% organic dye concentration ($\lambda = 622\text{ nm}$). 1 nm further is the photoluminescence maximum of the sample based on PVE with 10% organic dye concentration ($\lambda = 623\text{ nm}$), and the last is the photoluminescence maximum of the sample based on PEPK with 10% organic dye concentration. It is difficult to determine which factor has the greater impact on the photoluminescence maximum shift: dye content change or matrix polymer change. The differences between different polymers photoluminescence maximum location with 1% and 10% dye content are 12 nm and 9 nm respectively. The differences between photoluminescence maximum of the samples with 1% and 10% dye content are 10 nm and 13 nm for the samples based on PEPK and PVE respectively.

Typical current-voltage characteristic of the investigated sandwich-structures is shown on the figure 6. Qualitatively it is similar to based on PPV OLED's characteristic.

Typical sandwich-structure ITO/1%DCM in PVE/Al electroluminescence integral intensity dependence is shown on figure 7. Emission begins at voltages on the sample near 3V and rapidly grows up with the increasing of voltage. At voltages more than 10–15 V there are instability and degradation of the structure's characteristics.

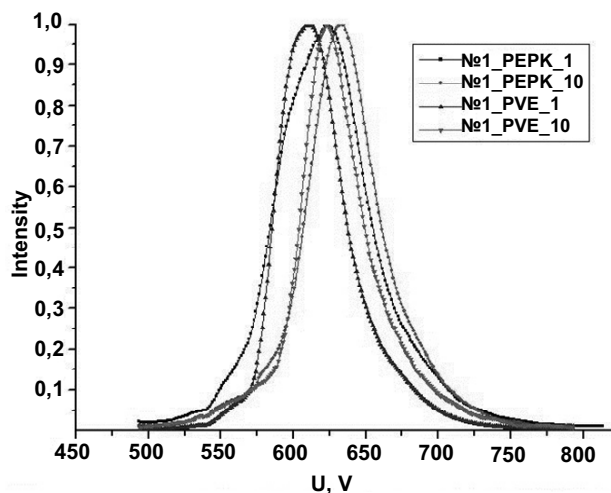


Fig. 5. Photoluminescence spectrum of 1% and 10% content of the dye №1 in PEPK and PVE

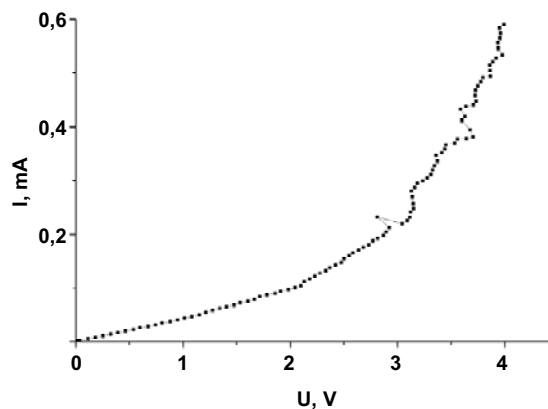


Fig. 6. Typical current-voltage characteristic of sandwich-structure ITO/1% DCM in PVE/Al

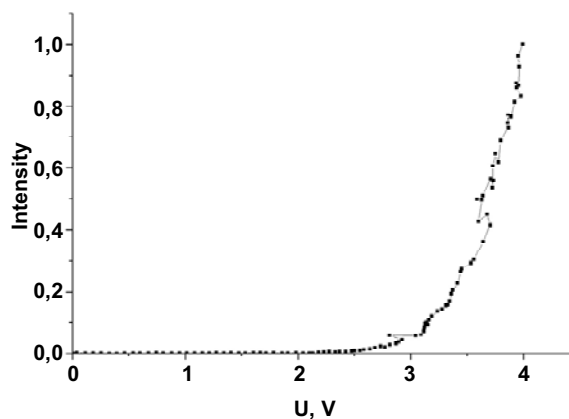


Fig. 7. Typical electroluminescence intensity of DCM in PEPK and PVE

Electroluminescence spectrum of the structure based on PPV is shown on the figure 8. Electroluminescence spectra of the investigated structures at voltages 15–25 V are analogous by form to electroluminescence spectra of the structures, based on PPV, and have a greater half-width.

Conclusions. Photoluminescence spectra maximum of the polymer 10% doped with the dye are shifted to the right approximately per 40 nm comparing to photoluminescence spectra maximum of the polymer 1% doped with the dye.

This value is 10 nm for polymers doped with the dye №1. Polymer PEPK doped with the dye DCM photoluminescence intensity maximum is shifted to the right per 10–15 nm from the analogous maximum for PVE. For polymers doped with the dye №1 this value is 9–12 nm.

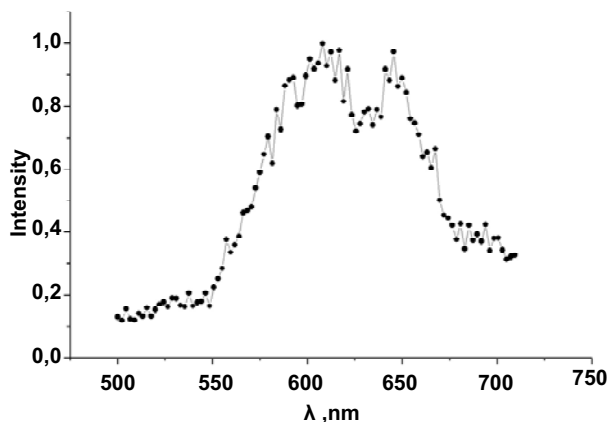


Fig. 8. Electroluminescence spectrum of the structure based on PPV at voltage $V = 30V$

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ЛЮМИНЕСЦЕНТНІ ВЛАСТИВОСТІ ОРГАНІЧНИХ БАРВНИКІВ У ПОЛІМЕРАХ РЕРК І PVE

Виготовлено сандвіч-структури для дослідження електролюмінесценції шляхом нанесення органічного шару методом центрифугування на скляну підкладку з ITO та напылення алюмінієвих контактів і зразки для дослідження фотоліумінесценції. Досліджено залежність зміни положення максимумів спектрів фотоліумінесценції від вмісту барвника і типу матричного полімера. Знято вольт-амперні характеристики виготовлених сандвіч-структур та встановлено залежність інтегральної інтенсивності електролюмінесценції від напруги.

Ключові слова: органічний барвник, РЕРК, PVE, ITO, сандвіч-структура, OLED, фотоліумінесценція, електролюмінесценція, PPV.

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ЛЮМИНЕСЦЕНТНЫЕ СВОЙСТВА ОРГАНИЧЕСКИХ КРАСИТЕЛЕЙ В ПОЛИМЕРАХ РЕРК И PVE

Изготовлено сэндвич-структуры для исследования электролюминесценции нанесением органического слоя методом центрифугирования на стеклянную подкладку с ITO и напылением алюминиевых контактов и образцы для исследования фотоліумінесценции. Исследовано зависимость изменения положения максимумов на спектрах фотоліумінесценции от количества красителя и типа матричного полимера. Снято вольт-амперные характеристики изготовленных сэндвич-структур и установлено зависимость интегральной интенсивности электролюминесценции от напряжения.

Ключевые слова: органический краситель, РЕРК, PVE, ITO, сэндвич-структура, OLED, фотоліумінесценція, електролюмінесценція, PPV.

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The instability of electroluminescence and electrophysical characteristics of the samples at voltages more than 10–15 V are found. Polymers, doped with organic dyes demonstrate characteristics, which are analogous to based on PPV structure's characteristics and can be used as a material for OLED's active layer.

REFERENCE:

1. Prosta realizatsiya metodu pidrahunku fotoniv dlia doslidzhennia spectriv poverhnevobarjernih nanogeterostruktur / S.V. Bunak, V.V. Ilchenko, O.M. Okoronko, A.G. Shkavro // Visnyk Kyivskogo universytetu, seria Fizyko-matematychni nauky, 2007. – № 4, P. 249–254.
2. Kelvin probe and ultraviolet photoemission measurements of indium tin oxide work function: a comparison / J.S. Kim, B. Lägél, E. Moons et al. // Synthetic Metals, 2000, Vol. 111–112, P. 311–314.
3. Structure and electronic properties of poly (3,4-ethylene-dioxythiophene) poly(styrene sulfonate) prepared under ultrasonic irremission / O. Yu. Posudievsky, N. V. Konoshchuk, A. G. Shkavro et al. // Synthetic Metals, 2014, Vol. 195, P. 335–339.
4. Issledovanie vliyania rassvoroiteley sopriazhennykh polimerov na harakteristiki planarnykh heterostruktur ITO/PEDOT:PSS/PF/AL I ITO/PEDOT:PSS/MEH-PPV/AL / V. M. Sorokin, Yu. V. Kolomzarov, M. A. Miniaylo et al. // Doklady BGUIR, 2011. – №3(57). – P. 81–86.

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PL AND FTIR SPECTROSCOPY OF POWDERED SILICA AEROGEL ar-SiO_x

Optical and photoluminescent properties of powdered silica aerogel ar-SiO_x have been investigated using FTIR spectroscopy and PL lifetime spectroscopy. Powdered silicagel was prepared from sodium silicate water solution using sol-gel technique. It was confirmed that the investigated material consists of two phases: stoichiometric SiO₂ and non-stoichiometric SiO_x. FTIR analyses reveal the presence of numerical hydroxyle groups which determines oxidative properties of the material and makes it a promising matrix for the incorporation of nanoparticles. The intense PL emission was detected in blue-green region with stipulated peaks at 1.9, 2.0, 2.2 and 2.6 eV. It was shown that emission properties of powdered silica aerogel ar-SiO_x caused by the presence of numerical oxygen defect centres: oxygen hole centers, peroxide radicals and oxygen-deficient centers as well as siloxane and silane groups. It was also obtained that under UV treating by pulsed laser irradiation the transformation the integrated PL intensity is decreased. The PL quenching is caused by transformation of the defect structure during photo oxidation process.

Keywords: powdered silica aerogel, defect states, FTIR transmission spectroscopy, PL lifetime spectroscopy.

Introduction. It is considered that porous oxide materials, possessing a large specific surface area, high porosity and fine grain structure, can be used as a comprehensive matrix for nanoparticles incorporation and molecular adsorption in order to create luminescent nanocomposites, photodetectors, catalysts, waveguides, lasers and gas sensors [1, 5, 12, 15]. The considered

nanoporous materials are simple and inexpensive in preparation, the gas sensor sensitivity can be significantly increased due to the enlarged overall active surface area.

The fact that typical aerogels have more than 90% porosity gives them unusual characteristics: they are characterized by extremely high surface area, high thermal resistivity, low dielectric constant and low refractive index.