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B-17

LUMINESCENT POLARIZATION MICROSCOPY OF SINGLE RADIATION DEFECTS

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Color centers in various crystals are widely used as working centers of gamma ray detectors, track detectors of charged particles and mixed fields of nuclear radiation, optical media for storing visual and digital information, laser media and passive laser gates, thin-film storage luminescent screens for visualization and digitization of X-ray microimages. The development of new principles of spectroscopic differentiation of radiation defects, complementing the traditional spectral-kinetic methods, the use of new spectroscopic characteristics, is relevant. This is particularly emphasized by the practical significance of use of radiation defects, including color centers, as model quantum systems that can be artificially created in condensed media by the action of hard radiation or laser radiation in various fundamental studies.

The aim of the presented research is to study the possibilities of spectroscopic differentiation of individual types of luminescent defects induced by radiation in condensed media, based on the comparison of generalized numerical characteristics of quantum trajectories of photoluminescence intensity, that are measured by confocal scanning luminescence microscopy on single defects in the mode of spatially selective time-correlated counting of single photons.

The possibility and effectiveness of the method of laser confocal scanning luminescence spectroscopy of single radiation defects based on the characteristics of their photoluminescent trajectories were experimentally confirmed. Dynamic models of F_2 and F_3^+ centers in lithium fluoride crystals were constructed. On the basis of the mathematical apparatus for the fluorescence of single molecules, in particular the equations for on- and off-intervals for a molecule with a triplet level, we introduced an additional equation describing the reorientation of the color center. The quantum trajectories of single F_2 and F_3^+ color centers obtained as a result of the calculation are in good agreement with the experimental ones.

The registered polarized quantum trajectories are shown to carry information about the structure, nature, dynamics of the quantum system and its local environment, on the example of the study of single color centers induced in the volume of a cubic crystal. A new method of laser scanning confocal fluorescence microscopy of single quantum systems located in a crystal matrix has been proposed, based on the analysis of the ratio of the intensities of polarized quantum trajectories (time dependences of the number of registered photons with vertical and horizontal polarizations for a fixed registration time). The mathematical apparatus and algorithms for the analysis of polarized quantum trajectories have been developed, and tables of sorts of quantum trajectories for all possible types of single color centers (quantum systems) in a cubic crystal have been formed.

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B-18

METHYLENE BLUE EXCITED ELECTRON STATES: PUMP PROBE SPECTROSCOPY

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Methylene Blue (MB) is a typical anionic dye and can be involved in the organization of complexes with a biological system through ππ-packing and electrostatic interaction. However, the

channels for the transfer of internal energy in the system of electronically excited states in the MB are still unclear. Sensitive fluorescent probe is a fluorescent molecule that binds to proteins, biological membranes or other components of a cell by non-covalent bonds. MB is used as a probe, the luminescence parameters of which change sharply depending on the properties of the environment. If the localization of the probe in the cell is known, then the change in the MV luminescence can suggest the physical properties of the immediate microenvironment of the probe molecules. Thus, the behaviour of proteins, membranes, nucleic acids is studied. Other structure properties of a biological system become immediately clear. When the environmental conditions around the MV change, then the nature of the spectra and the quantum yield of fluorescence also change. In our work, we used electron absorption spectroscopy, stationary fluorescence, and pump-probe spectroscopy [1] to study the migration of excitation energy in MB dissolved in various solvents.

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1. *Svetlichnyi V.A.* // Instruments and Experimental Techniques. 2010. V. 53, No. 4. P. 575–580. DOI: https://doi.org/10.1134/S0020441210040196.

B-19

FLUORESCENT CHEMICAL SENSORS IN LASER GENERATION MODE

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Investigations aimed on the detection of harmful substances for human life are very exist. Nitrocompounds are included among many. Among numerous chemical compounds contaminating the environment, a prominent place is occupied by nitroaromatic compounds, many of which enter the composition of explosive materials. They are contained in industrial waste and are toxic for living organisms. Of the wide variety of methods for detecting chemicals, method based on the quenching of fluorescence of organic compounds is a simple and fairly sensitive.

Sensor properties of poly[9,9-dioctylfluorenyl-2,7-di-yl] compounds with end groups dimethylphenyl (ADS129), poly [9,9-dioctylfluorenyl-2,7-di-yl] with end groups polysilsexvioxane (ADS229) were studied. A thin film planar waveguide structure is formed and lasing is obtained in ADS129 and ADS229 polymer compounds under excitation by the third harmonic of a Nd^{3+}:YAG laser (335 nm) in the presence of nitrotoluene (NT).

Recently, to broaden the dynamic range and increase the sensitivity of optical chemical sensors, enhanced attention has been paid to the use of thin-film organic laser active media. The thin film element radiation intensity in the threshold laser regime depends on the chemical composition of the surrounding medium, and the presence of a small amount of a material quenching the luminescence can lead to complete oscillation suppression.

In this work, it is shown that a waveguide laser in a simple planar geometry with the use of an additional layer, which improves the optical waveguide properties, has a low lasing threshold and a fast response to the presence of NT.

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SYNTHESIS AND CHARACTERISTICS OF NANOPOWDERS AND CERAMICS OF ALUMINUM–MANGANESE SPINEL DOPED WITH IRON

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A technology for the preparation of nanopowder and ceramics of aluminum–manganese spinel doped with iron has been developed. In this case, nanopowders were synthesized using a laser ablation method with subsequent condensation of vapors in a carrier gas flow.