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Portable sensor platform based on plasmon-enhanced fluorescence for explosives detection

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The global challenge of rising terrorism has been further complicated by the war in Ukraine, which has led to extensive contamination of soil and water resources with explosives and their byproducts. This situation underscores the urgent need to develop a sensitive, rapid, low-cost, portable, and easily mass-produced sensor for explosive detection.

A promising approach for detecting various molecules is plasmon-enhanced fluorescence [1], which also shows potential for the detection of explosive molecules through the use of specific fluorophores [2]. In this work, new sensor fluorescent nanomaterials and a prototype of a portable sensor device for detecting molecules of a number of chemical analogs of explosive aromatic nitro compounds were developed.

Sensitive sensor elements based on the nanocomposites of fluorescent materials sensitive to explosives (pyrene, fluorene derivative F8BT, poly(phenylenevinylene) derivatives MEH-PPV and p-PMEH-PPV) with plasmonic nanostructures of noble metals in colloidal form and on substrates embedded into different polymer matrices, including acrylamide-based molecularly imprinted polymers, were prepared in the form of solid-state chips and paper-based carriers and characterized by microscopic and spectroscopic techniques to optimize their plasmon-enhanced fluorescence response. It was also found that pyrene and MEH-PPV fluorophores exhibit the highest fluorescence quenching against chemical analogs of explosive aromatic nitro compounds such as 4-nitrophenol and 4-nitrotoluene. The sensing properties of the prepared nanocomposites were investigated by analyzing fluorescence quenching response to different aromatic nitro compounds both in the gas and liquid phase to find their limits of detection, which reach 10-16 M for Ag nanoparticles/pyrene/polyvinylpyrrolidone thin films.

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Authors: Dr LOPATYNSKYI, Andrii (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine); Dr LYTVYN, Vitalii (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine); Dr DEMYDOV, Petro (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine); Ms KHUTKO, Mariia (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine); Mr KUZNIETSOV, Victor (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine); Mr HUDZENKO, Illia (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine); Prof. CHEGEL, Volodymyr (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine)

Presenter: Dr LOPATYNSKYI, Andrii (V. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine)

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