Acoustic surface waves in investigations of sensor properties of thin films of selected polymeric compounds using additional activation methods

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Summary

The dissertation presents results of the study carried on improving the sensitivity of thin-film sensors made of photoconductive polymers such as regioregular Poly(3-hexylthiophene) (RR)-(P3HT), and SilPEG 1.4 Polysiloxane (a copolymer formed from P3HT polymer doped with PEG chains) deposited on 205 MHz SAW modules. It was used for detecting trace amounts of DMMP (simulant of the poisoning agent sarin) in the air. During their exposure, additional activation methods (optical or optical-thermal) by illuminating them with light sources (white light, LEDs, laser LEDs), of different wavelength and flux densities were used. The main focus was on optical activation, due to the need to develop a fundamental understanding of the feasibility of an energy-efficient WBT gas sensor in the future.

The essence of the proposed optical activation method is to find appropriate wavelengths of light and flux density, when incident on a SAW structure with a suitable chemosensitive polymer layer, will result in a significant improvement in the adsorption and desorption parameters for trace amounts of the DMMP compound in an air atmosphere at room temperature.

A dedicated specialized 205 MHz generator based on switchable SAW delay lines was designed and assembled. The designed generator is a unique implementation. It brings a new approach to measurements technique in reference to methods commonly used and shown in the literature. This solution allowed to improve the quality of obtained measurement results.

The author implemented the automatic measuring station using a developed generator. It allows carrying out a series of experiments using additional optical activation of the thin layer of photoconductive polymers in the evaluated sensor. There were evaluated Poly(3-hexylthiophene)(RR)-P3HT, and Polysiloxane SilPEG 1.4, in studies on the detection of trace amounts of DMMPs in the air.

Carried out research proved that in AFP sensors additional light activation allows increasing sensitivity. There were evaluated thin films of polymeric compounds of (RR)-P3HT and SilPEG 1.4 types towards detecting trace amounts of the DMMP simulant. The sensing properties of this type of photoconductive polymers are significantly enhanced by light stimulation. This makes it possible to solve the problem of low sensitivity in the range of low vapor and gas concentrations at room temperature. Activations of this kind can also be used in the design of biosensors with AFP for the detection of ions, bacteria, and viruses. In these applications, solving the problem of low sensitivity is crucial for the correct detection of such substances. The methods of optical activation of thin films proposed in the dissertation can be described as active sensor structures, which in AFP sensors is a new solution for increasing the sensitivity of polymeric compounds with photoconductive properties.