Plasmonic interactions in the polymer hybrid nanostructures for the optoelectronics applications

In this work selected properties of polythiophenes and polyfluorenes, as well as of a group of four new rhenium complexes containing terphyridine-based ligands, were investigated. The results of studies describing plasmonic interactions in hybrid nanostructures composed of polymers or low molecular weight compounds and silver nanowires were presented. It has been shown that depending on the spectral properties of the investigated materials, plasmonic excitations in silver nanowires can cause an increase or decrease of fluorescence in these materials. The results of stationary spectroscopy, time-resolved spectroscopy, and fluorescence microscopy were presented. The experiments were carried out in order to investigate potential of these materials as building blocks in optoelectronic devices, such as organic solar cells and light emitting diodes. Optoelectronic devices containing investigated materials were fabricated, and the results of measurements of electroluminescence spectra and current-voltage characteristics were presented.

For hybrid nanostructures composed of P3HT polymer and silver nanowires more than twofold increase of fluorescence intensity was observed. Measurements of fluorescence decays showed that increase of absorption rate is the main mechanism responsible for the enhancement of the P3HT emission . Moreover, it has been shown that the introduction of silver nanowires into solar cells, in which P3HT polymer serves as the active layer, improves the parameters of these devices by increasing the I_{SC} value.

Further studies showed that differences in the spectral properties of PFO and F8BT polymers can affect the interaction of these materials with silver nanowires. Absence of overlap between the absorption and emission spectra of PFO polymer with the absorbance spectra of silver nanowires results in the decrease of PFO fluorescence . In contrast, overlapping of the absorption and emission spectra of F8BT polymer with the absorbance spectra of silver nanowires results in the increase of fluorescence of F8BT polymer. It was also shown that both polymers exhibit good electroluminescent properties. Measurements of current-voltage characteristics show that for OLED containing silver nanowires the current density for the same voltages can be increased.

Furthermore, the results for four newly synthesized rhenium complexes containing terpyridine- based ligands were presented. It has been shown that silver nanoparticles increase the intensity of fluorescence of the investigated complexes. This new group of materials

exhibit electroluminescence and can be used as an active layer in OLED. It has been shown that the introduction of silver nanowires to electroluminescent diodes can increase the current density for the same voltages and significantly increase the intensity of electroluminescence.

The results of the experiments showed that the introduction of silver nanowires into optoelectronic devices can lead to improved properties of these devices. It has been shown that silver nanowires can increase the absorption of organic solar cells, as well as increase the current density and intensity of electroluminescence in organic light emitting diodes.