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ABSTRACT

Application of natural and synthetic polymers for preparation of nanostructures containing dyes

This dissertation presents the results of research on the synthesis and properties of new photoactive: methacrylic polymers, hybrid materials and chitosan derivatives containing azobenzene moieties. The main goal of the work was to develop methods for the synthesis of new photosensitive materials, methods for the modification of chitosan with azobenzene dyes and investigation the photochromic properties of the obtained materials. Synthesized materials were used to form micro- and nanostructures with different morphology. The fabricated micro- and nanoobjects were than irradiated with light to determine their photochromic response.

The dissertation begins with a brief introduction, a summary and a list of abbreviations used. The theoretical section presents the general information about photochromism and mechanisms responsible for this phenomenon. The photosensitive polymer materials containing photochromic species of various types as well as main fields of applications of this group of materials are presented. This part of dissertation contains a description of techniques used for polymer micro- and nanostructures fabrication. The experimental part contains detailed descriptions of the performed synthesis, the characteristics of the obtained materials and applied methods and techniques. The most extensive part of the elaboration is discussion of results. The dissertation is concluded with a short summary.

The main part of this work was the development of methods for the preparation photochromic micro- and nanostructures as well as optimization of the fabrication process parameters. The micellization method, emulsion-solvent evaporation method, electrospinning and electrospraying techniques were used for fabricating polymer micro- and nanoobjects. A thorough analysis of the influence of preparation process parameters on size and polydispersity formed micro and nanoobjects was carried out. Size of the obtained objects

was determined by dynamic light scattering (DLS). Optical microscope and scanning electron microscope (SEM) were used to examine morphology of the micro- and nanoparticles. The photochromic properties were confirmed by UV-Vis spectroscopy and ellipsometric measurements. Kinetics of trans-cis photoisomerization of azobenzene group under light illumination and the thermal relaxation was estimated. The change of the real part of the complex refractive index induced by laser irradiation was determined. Based on these results, the ability to form surface relief gratings upon irradiation with one laser beam with 473 nm wavelength was investigated. The efficiency of SRG inscription in the thin azopolymer films and in the layer of colloidal spheres was compared. Moreover, the obtained azopolymer spherical particles were deformed upon illumination with linearly polarized light, according to the direction of the light polarization. Moreover, the wettability measurements of the glass microscopy slides covered with hybrid electrospun fibers were carried out. The effect of the trans-cis photoisomerization on the value of the contact angle was investigated. The value of the water contact angle of this surface, following the isomerization process, decreased by 5-10° after irradiation with laser beam 404 nm.

The results of the research were published in two scientific papers, presented on the national and international scientific conferences and have become the object of the five patent and eight patent application.