Abstract

The aim of the doctoral thesis concerns investigations of azopolymers focus on determination of the relationship between its chemical structure and both physical and induced by polarized light properties. The subject of the research was the polymers with aromatic imide rings and the ester or ether groups in the polymer backbone, containing derivatives of azobenzene or azopyridine. Azochromophores were covalently bonded to the macromolecular chains or molecularly dispersed in polymer matrix formed "guest-host" systems. In the frame of work, the synthesis of low molecular weight compounds and polymers were carried out. The synthesized 8 low molecular weight compounds were used to obtain 4 poly(ether imide)s and 3 poly(ester imide)s. In addition, 2 poly(ether imide) matrices were synthesized, which together with the commercially available poly(ether imide), were used to prepare 38 "guest-host" polyimides. The investigated azopolymers formed a good quality films on glass substrate and in some cases the foils were obtained. It should be stressed, that free-standing materials - foils preparation form azocompunds functionalized polyimides is not easy task.

The effect of such selected elements of azopolymer structure as the structure of both the main polymers chain and azochromophores, the method of azomolecules chromophore assembling with the polymer backbone and its content on solubility, thermal, thermomechanical, mechanical properties, *trans-cis-trans* isomerization, photoinduced birefringence and photomechanical effect was analyzed. It should be noted, that thermomechanical and mechanical properties of azopolymers are seldom reported in the literature. Moreover, there is not much works concern the study of the *trans-cis-trans* isomerization of azochromophore solutions, in particular of azopyridine derivatives. To the best of our knowledge, the kinetics of the *trans-cis-trans* azopolyimides isomerization in a solid state is presented for the first time in this PhD thesis.

Polymers with the best physical and induced by polarized light properties were examined for the potential application including: (i) the fabrication of photonic structures in cooperation with the Faculty of Chemistry of the Wrocław University of Science and Technology and the Faculty of Physics of the Warsaw University of Technology, (ii) the preparation of layers for the liquid crystal alignment with the Institute of Applied Physics of the Military Technical Academy in Warsaw, and (iii) the use of azopolyimide as membranes for gas separation in cooperation with the Centre of Polymers and Carbon Materials PAS in Zabrze.

The innovative nature of the presented dissertation concerns the modification of the chemical structure of the polymers, which allowed to obtain: (i) main-chain functionalized azopolyimide with a record high photoinduced birefringence, (ii) "T-type" azopolyimide, which very high the diffraction efficiency and surface amplitude modulation similar to those reported for the azopolymer with a much higher azochromophore content in the repeating unit and (iii) the "guest-host" system with the surface relief grating modulation significantly exceeded the results obtained for the systems with a much higher content of azochromophore, described in the literature. Moreover, it was showed the photomechanical effect can be observed not only in functionalized azopolymers but also in "guest-host" azosystems. For the first time the main chain functionalized azopolyimide was used as a gas separation membrane.

The results obtained in presented dissertation extend the knowledge of azopolyimides and may be also important from the point of view of potential applications.