Abstract of doctoral thesis

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"New azopoly(amide imide)s and azopoly(ester imide)s: investigations of the influence of the chemical structure on the physical properties, including the photoinduced optical birefringence"

The doctoral thesis was done in Centre of Polymer and Carbon Materials of PAS in Zabrze

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The aim of the work was synthesis of novel, processable azopolymers and study of their selected physicochemical properties as well as the properties induced by the polarized light. The research was devoted to photochromic polyimides containing the amide or ester groups and derivatives of azobenzene or azopyridine. The azo-dyes were covalently bonded to the polymer main chain or formed "guest-host" polymers. The selected azopolyimides were applied as layers for the liquid crystal alignment within the cooperation with the Institute of Applied Physics of the Military Technical Academy in Warsaw.

In a detailed study of physicochemical properties the attention was focused on determining the effect of such elements of polymer structure (including the possibility of formation of the hydrogen bonding) as (i) structure of the main chain, (ii) the type of azo-dye, as well as the type and place of azo-dye connection to the polymer macrochain, (iii) quantity of the azo groups in the repeating unit, on the amorphous structure, solubility, film forming properties, thermal and absorption properties in the UV-vis spectrum and the photoinduced birefringence.

In this dissertation 21 low molecular compounds were prepared and used to synthesize 47 polymers, including 10 poly(amide imide)s and 7 poly(ester imide)s with covalently bonded derivatives of azobenzene, 5 poliimide matrices used to prepare 25 "guest-host" polyimides containing derivatives of azobenzene or azopyridine. It should be noted, that polyimides with derivatives of azopyridine have not been investigated in the context of generating the photoinduced birefringence yet. Moreover, systematic research on the influence of the chemical structure of azopolyimides on Δn has not been conducted. The innovative nature of this work is mainly related with the proposed modifications of the materials structure, which allowed to obtain polymers with a higher and more stable Δn value, with respect to the polyimides presented in the literature. In particular, the novelity of this work lies in applying the Fox's formula to determine the glass transition temperature of

“guest-host” polyimides. In addition, the DFT method was used for determining the possibility of formation of the hydrogen bonding in “guest-host” systems. The DFT results were confirmed by experimental methods (^{1}H NMR and FTIR).

The results obtained in the doctoral thesis allowed to formulate the relationships between the chemical structure of the investigated polymers and physicochemical properties including photoinduced birefringence values and its stability. In addition, the importance of the hydrogen bonds formation on the process of birefringence generation and relaxation was shown. The obtained results extend the general knowledge on azopolymers and may be also important from the point of view of potential applications, in particular as the layers for the liquid crystal alignment in optoelectronic devices: liquid crystal diffraction gratings, Fresnel’s lens and the structures that generate optical vortices.