Spectral photosensitization of optical anisotropy in poly(vinyl cinnamate) solid films

IOP Conf. Series: Journal of Physics: Conf. Series **867** (2017) 012039 doi:10.1088/1742-6596/867/1/012039

Spectral photosensitization of optical anisotropy in poly(vinyl cinnamate) solid films

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Abstract. We observed possibilities and properties of sensitized photo induced optical anisotropy formation in amorphous poly (vynyl-cinnamate) films (PVCi) and its derivant poly (vynyl-4-methoxy-cinnamate) (PVMCi) under polarized light, including the one which is not absorbed by the supermolecules of the polymeric material. The effect of the induced optical anisotropy involves transferring the energy of electronic excitation from the donor molecules (Michler's ketone or 2-benzoyl-methylene-3, methyl-β-naphthosol) to the scavenger's molecules - PVCi or PVMCi) and photo-topochemical ring formation of cinnamate units in polymeric supermolecules. The discovered photo-induced anisotropy in solid PVCi and PVMCi films provides sensitized photo orientation of low-molecular thermotropic liquid crystals.

Key-words: photo-induced optical anisotropy, double refraction, poly (vynyl-cinnamate) photosensitization.

1. Introduction

The goal of current work is to analyze the formation of sensitized photoinduced optical anisotropy in amorphous poly(vynyl-cinnamate) films (PVCi) and in its derivant poly(vynyl-4-methoxy-cinnamate) (PVMCi) [1-3] under the influence of polarized light as well as to find physical mechanisms of this process so that it could improve the materials efficiency in different optics and optical information processing tasks [4-6].

2. Results and Discussion

The initial kinetics sections of POA formation within $PVMC_i$ layers, sensitized by BNT naphthotiazoline are shown in fig. 1 a–c for different wave-lengths when λ_{exp} = 436, 405 and 365 nm. The radiation with a wave-length of 436, 405 nm is absorbed only by BNT molecules and the latter wave-length lies within the maximum BNT absorption (~ 400 nm). As can be seen in fig. 1a and 1b, in $PVMC_i$ (curve 1) no POA is formed without a sensitizer. When activated with the wave-length of 365 nm, where the UV radiation is absorbed by both components, the formation speed has its maximum without any sensitizer (fig.1c, curve 1). In this case, if the sensitizer concentration increases, the POA formation speed decreases substantially (curve 2 and 5). This phenomenon has an inverse trend when the wave length is 436 nm, which is presented in substantial increase of photo-induced double refraction (DR) together with the BNT concentration increase in the PVMCi layer (fig.1a curve 2 and 5). For the radiation at 405 nm the effect of DR induction speed increase (fig.1b, curve 2 and 3) can be

observed only with low concentration ~ 0.5 – 1.0 % and decreases when the concentration gradually grows (fig.1b, curves 4 and 5).

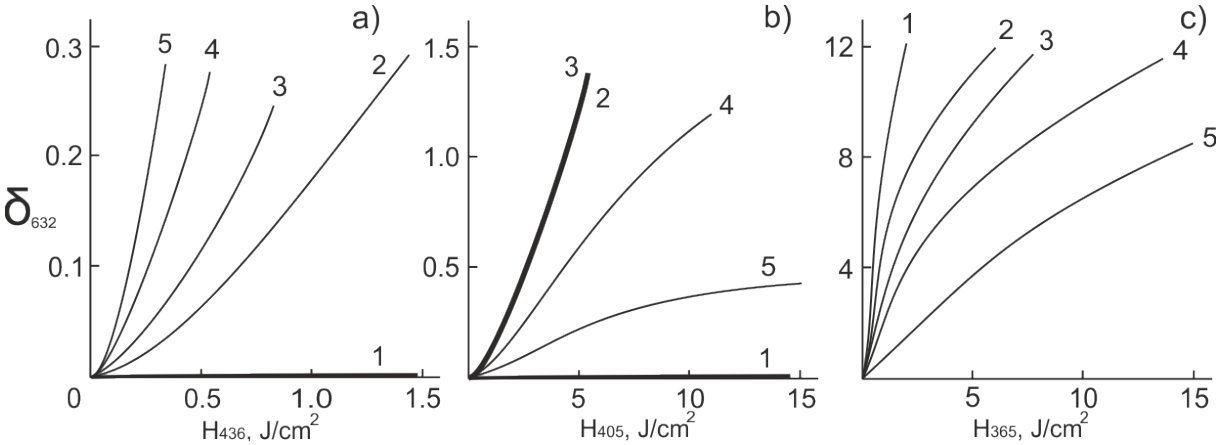

Fig.1. The initial kinetics sections of photo-induced phase retardation δ_{632} within PVMCi layer with BNT addition with concentration of 1–0%; 2–0.5%; 3–1.0%; 4–2.0%; 5–4.0% as energy function H_{exp} with radiation λ_{exp} – (a) 436 nm, (b) 405 nm и (c) 365 nm.

An unsensitized PVCi layer (fig.2, curve 1), as well as the similar PVMCi level, doesn't absorb with the wave-length more than 400 nm and, as the result, doesn't create POA effect under the radiation of λ_{exp}=405 nm. It appears only with sensitizer, and moreover, the speed and the value of the induced phase retardation increases due to the increased Michler's kethon (MK) sensitizer concentration in the layer.

In PVMCi film without the sensitizer and with the radiation of λ_{exp}>400 nm (curve 1 in figure 1a and 1b the POA effect is missing, i.e. each reaction component doesn't create any POA effect by itself. PVCi doesn't absorb with the wave-length more than 405 nm, and MK sensitizer's molecules are photochemically stable.

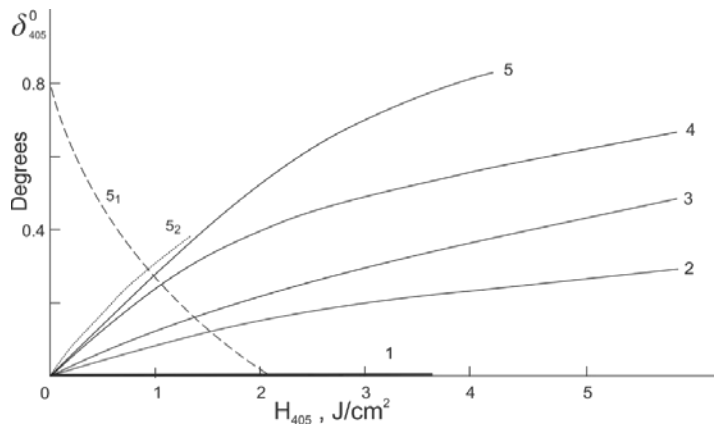

Fig.2. Photo-induced phase retardation kinetics δ_{405} in PVCi layer with MK addition with the concentration of 1–0%; 2–0.5%; 3–1.0%; 4–2.0%; 5–4.0% as energy function with radiation of λ_{exp} = 405 nm.

The induced anisotropy can be optically "erased" as shown in figure 2 curve 5_1 and restored as in fig.2 curve 5_2.

Acknowledgements
This research was supported by RFBR, Research Grant No. 17–47–500757, and Ministry of Education, Investments and Innovations in Moscow Region, Russian Federation Presidential Grant No. MK–7359.2016.9.

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