STUDY OF OPTICAL PROPERTIES BIREFRINGENT OF HEMA - DR13

ESTUDIO DE LAS PROPIEDADES ÓPTICAS BIRREFRINGENTES DEL HEMA –DR13

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ABSTRACT

Mercado Gutiérrez, E., C. Maestre Molinares, S. Valbuena Duarte, F. Racedo Niebles. Study of optical properties birefringent of hema - DR13. Rev. Acad. Colomb. Cienc., 37 (1): 27-30, 2013. ISSN 0370-3908.

The following paper is a detailed study of the optical properties of HEMA-DR13 from optical birefringence can be induced azopolymeric material. Based on the method of two-photon absorption, anisotropy is generated due to the reorientation of the chromophores in the sample of HEMA-DR13. Using allow-power laser He-Ne, and a laser Nd-YAG medium power, it was possible to implement an optical system which allows observing the subsequent quantification of photoinduced birefringence in said material. Subsequently comparing the results obtained with different theoretical models, thereby determining the characteristic times (time of excitation and relaxation time) of HEMA-DR13. Additionally, a study of the response signal based on the excitation power and the temperature of the material being able to obtain the relationship between this variables and the intensity of birefringence.

Key words: Two-photon absorption, Photoinduced birefringence, Azocompounds.

RESUMEN

En el siguiente trabajo se hace un estudio detallado de las propiedades ópticas del HEMA - DR13 a partir de la birrefringencia óptica que se puede inducir un material azopolímerico. Basándose en el método de absorción de dos fotones, se generó una anisotropía debida a la reorientación de los cromóforos que componen la muestra del HEMA – DR13.Utilizando un láser de baja potencia de He - Ne y un láser de Nd - YAG de mediana potencia, se logró implementar un sistema óptico el cual permite observar para su posterior cuantificación de la birrefringencia foto inducida en dicho material. Posteriormente se comparan los resultados obtenidos con los diferentes modelos teóricos, determinando así los tiempos característicos (tiempo de excitación y tiempo de relajación) del HEMA – DR13. Adicionalmente se hace un estudio de la respuesta de la señal en función de la potencia de excitación y de la temperatura del material logrando obtener la relación que existe entre estas variables y la intensidad de la birrefringencia.

Palabras clave: Absorción por dos fotones, Birrefringencia fotoinducida, Azopolímero.

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1. Introduction

The phenomenon of photo isomerization the azocompounds have been studied for several years [7] with the aim of finding ever more effective [2,3]materials and with a much faster response photosensitive, so they can be used in photonic technologies, storage and temporary[5]. That is why a study of birefringent properties of azopolymer 2-hydroxyethyl-methacrylate and 4 - [Nethyl-N-(2-methacryloxy-ethl)]-amino-2'-chloro-4'-nitro-azobenezene (HEMA - DR13) through photo isomerization reversible Trans - Cis - trans birefringence can be induced in azopolymer linearly polarized light using low power, this causes the photo orientation of the chromophores in the material causing a change in the dipole moment of these, by means of a lateral movement mechanism, now called inversion mechanism. Chromophores rotate in a free volume perpendicular to the applied external electric field. The induced birefringence is through photo isomerization Trans - Cis – Trans[1,3]. Applying an external electric field generated by a laser beam is achieved by this process.

2. Material and Methods

Synthesis HEMA DR13 samples obtained from crystallization method by solvent evaporation of two monomers which were, tris (2-hydroxyethyl) isocyanurate triacrylate (monomer A) and ethoxylated (6) Trimethylol propane triacrylate (Monomer B) acts as the first generator in material hardness, while the second is responsible for reducing the rigid clumps in the mixture, the mixture was added disperse Red 13 (DR13) which provides mobility as the photosensitive compound. The mixture was dissolved in ethanol, an inert solvent in the reaction of the monomers A, B and DR13, the mixture generated a viscous dark red and is deposited on a glass substrate subsequently processed samples were exposed to a temperature approximately 70 C in an atmosphere saturated with the same solvent. Once developed HEMA DR13 samples proceeded to perform the experimental setup which allowed induce birefringence in that azopolymer. Figure 1 shows a diagram of the experimental setup used to measure the photo-induced birefringence [3,6].

The experimental setup for measuring the birefringence comprises two lasers, laser He - Ne linearly polarized, whose wavelength is 632.8 nm and 1 mW of power, in our description we call this, the read laser and which is responsible for verifying the polarization state of the chromophores of the polymer network of HEMA - DR13. Moreover laser used a medium power Nd: YAG linearly polarized with a wavelength of 532 nm power of 100mW, this is the writing laser or laser excitation chromophores which react to the field applied electric and thereby inducing birefringence in the material. Figure 1 show the experimental arrangement used.

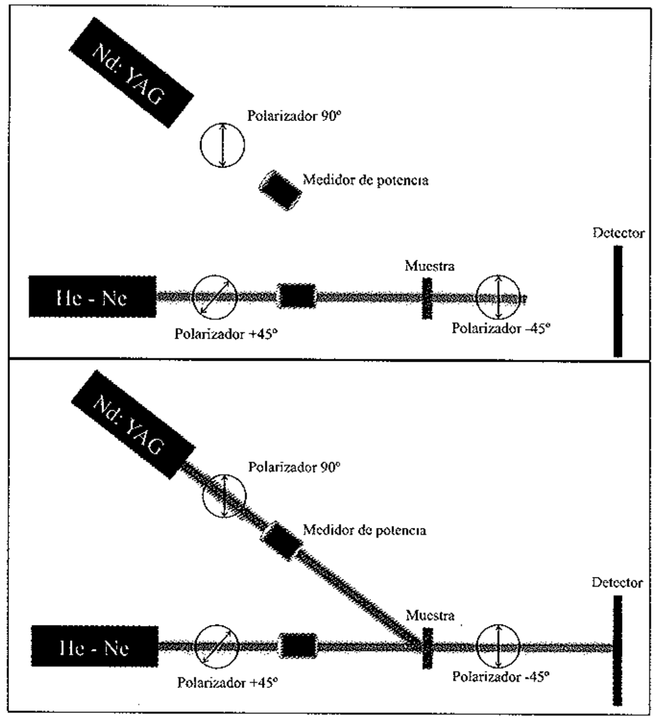

Figure 1. Experimental scheme to measure the birefringence induced in samples HEMA - DR13

Two crossed polarizers are each responsible for controlling the amount of light reaching the photodetector, sign azopolymer interposing between the two polarizers, which is verified is the state of the photo isomerization in the chromophores found in the sample (Figure 1). When the excitation laser is turned on and calibrated to a determined power, is incident on the sample, taking into account that the writing laser beam must have a polarization of 90 to the incident read laser beam. Note that this difference in the angle of the polarizers must be in a relationship of 45 to the writing laser and -45 to the reading laser. This is because chromophores exhibit a maximum in the intensity of the transmitted signal when the angle of polarization of the writing laser is 45 or -45.

The experiment was conducted at a temperature of 24C finds, which was the ambient temperature at which the experiment was developed. At the time the writing laser is not incident on the sample of azopolymer, do not get any signal from the reading laser.

3. Results

At the time of the writing laser light with a power of 4.5 mW, begins the process of photo isomerization in the sample of HEMA - DR13. When the writing laser impinges on the material of the polymeric network chromophores begin to orient perpendicular to the external electric field by changing the dipole moment of the chromophores and thus changing the polarization state of laser beam that passes through the sample. In Figure 3, the signal is observed photoinduced birefringence for a sample of HEMA - DR13 containing 70% by weight of monomer A and 30% by weight of monomer B. The duration of the writing laser incident on the sample was 15 minutes, was withdrawn When excitation source, the duration of the signal acquisition to photo isomerization Cis - trans was also 15 minutes. In figure 3 shows an increase in the transmitted signal as chromophores change state Cis to state Trans photo isomerization the first stage of Trans - cis. Then when the chromophores are at a maximum value of orientation is removed, the excitation source thermal photoisomerization starting Cis - Trans.

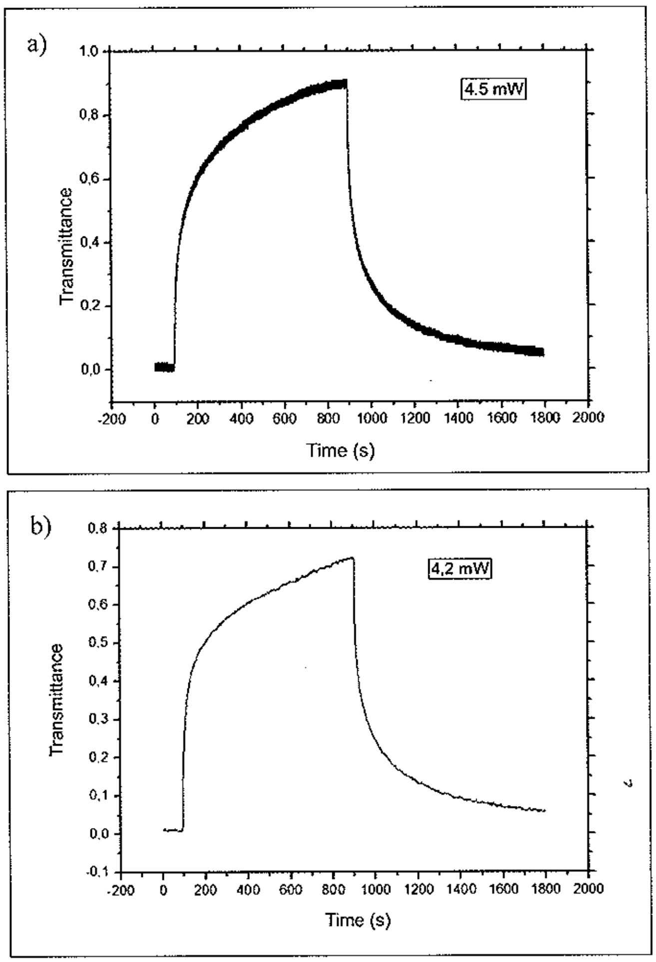

Figure 2. Photoinduced birefringence curves for the HEMA - DR13. a) Signal transmission reading laser in the process of photo isomerization Trans - Cis - Trans, for excitation power of 4.5 mW. b) Signal transmission reading laser in the process of photo isomerization Trans - Cis - Trans, for excitation power of 4.2 mW.

In the figure 2 is induced birefringence for excitation power of 4.5 mW and 4.2 mW respectively, showing the same behavior but with deference in the maximum signal obtained for each. The variation of the excitation power is shown in figure 3.

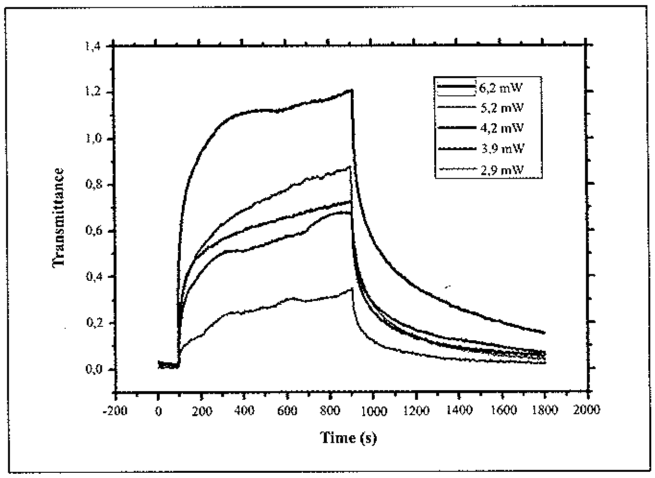

Figure 3. Curve of the induced birefringence in HEMA - DR13 for different excitation powers an Nd: YAG.

Model using the bi-exponential function, which describes the transmission of the induced birefringence as

$$T = A_f[1 - exp(-t/\tau_f)] + A_s[1 - exp(-t/\tau_s)]$$

for excitation and relaxation

$$T = A_f[exp(-t/\tau_f)] + A_s[exp(-t/\tau_s)]$$

results were adjusted experimentally to obtain the characteristic times of HEMA - DR13. Settings function model bi – exponential shown in figure 4.

Figure 4a shows the results obtained in the process of photo isomerization Trans - Cis, where the black line represents our experimental curve, while the color represent bi exponential function for different characteristic times. Then in Figure 4b shows the process that occurs when we remove the write laser, it shows the experimental curve (blackline) against bi function curve - exponential relaxation process. In Table 1 the data from Figure 4 are shown.

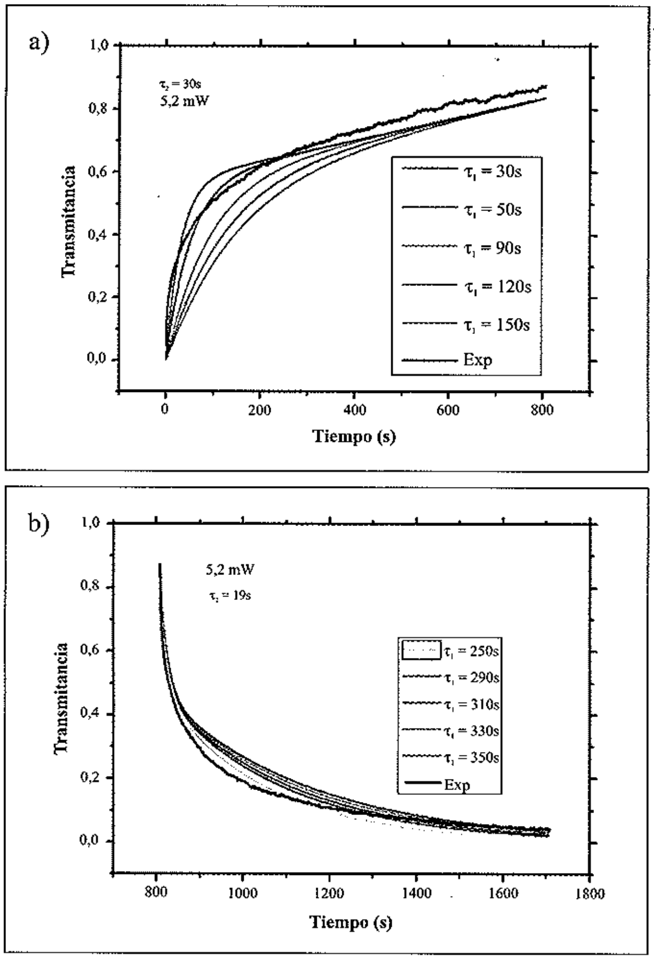

Figure 4. Show the relationship between the model function bi - exponential with theoretical curves obtained experimentally. a) Process photo isomerization Trans - Cis. b) Photo isomerization process Cis - Trans.

Table 1. Shows the parameters that describe the phenomenon of Trans Cis Trans photo isomerization, through bi function - exponential for HEMA -DR13.

	A_f	τ_f	A_s	τ_s
Excitation	0.57	30	0.3	30
Relajation	0.47	19	0.4	250

4. Conclusions

Was synthesized samples azopolymer HEMA - DR13, by the method of deposition by evaporation of the s olvent, and that the samples were of excellent quality. Additionally, an experimental setup was achieved high accuracy to obtain the curves of HEMA - DR13, so that it could make variations in the excitation power and reproduce easily bends. Further experimental data were compared with the model of the function bi - exponential, where comparing the different data and thus to obtain the characteristic times of excitation and relaxation for the HEMA - DR13. Achieving establish the model of bi exponential function as an effective model for describing the photo isomerization azoaromatics molecules. By varying the excitation power is able to observe the strong dependence of the excitation power with the birefringence induced in the material, this indicates that we can control the intensity of the signal by means of this variable. Thus allowing for the HEMA - DR13 is a photosensitive material and capacity to be used as information storage device.

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