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Optically induced birefringence in a azopolymer based on the phenomenon of photo-isomerization

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Abstract. The following article is a study of optically induced birefringence in an azopolymer Hema - HDR13. Generating anisotropy in the material through the photo-isomerization process for azo - compounds, chromophores are reoriented in the material through an external electric field, from an Nd: YAG laser, emitting with a wavelength of 532.8nm Based on an absorption spectrum on an azopolímero samples was determined that the wavelength at which the phenomenon is given. Measurements were obtained for samples birefringence how efficient are able to observe the samples so that they can be used as raw material for optical storage devices. Varying the excitation laser power (Nd: YAG) were observed variations in signal strength, making observe a maximum saturation power chromophores which are reoriented in the sample. Also analyzed the theoretical models of photo - molecular orientation, and succeeded in identifying which of them corresponds to the results and establishing the characteristic times appearing in each for Hema - DR13.

1. Introduction

The azopolymers are compounds which react to a stimulus characteristic radiation, causing a change in some physical and chemical properties in them. Some physical properties that may occur in the molecule is the change in the electric dipole moment, and change in geometry due to an inversion or rotation mechanism. This is thanks to the feature that shows the azo, azo functional group-N = N-azo. The used in the development of this work was the 4 - [N-ethhyl-N-(2-ethyl-methacryloxy)] -amino-2-chloro-4-nitroazobenzene, known for short as HEMA - DR13 which is a compound that has a very stable and has been the subject of many studies and research based on this phenomenon. Figure 1 shows the chemical structure of HEMA DR13, where one can observe the azo functional group attached to two aromatic rings which has a large carbon chain, with the particularity that the opposite ends of the molecule have a high electronegativity together. The functionality of this feature consists in the provision of the molecule to behave like an electric dipole in presence of an external electric field [1].

The photo isomerization process occurs when the linearly polarized light of a specific wavelength located in the range of absorption of the sample is incident on the molecule. In the steady state the molecule is in the trans isomer which is the lowest energy when the molecule is excited, and changes the cis isomer by means of the rotation mechanism or the inversion of the aromatic rings.

The photo - isomerization process trasn - cis - trans anisotropy occurs in the molecule giving rise to the photo-induced birefringence [2].

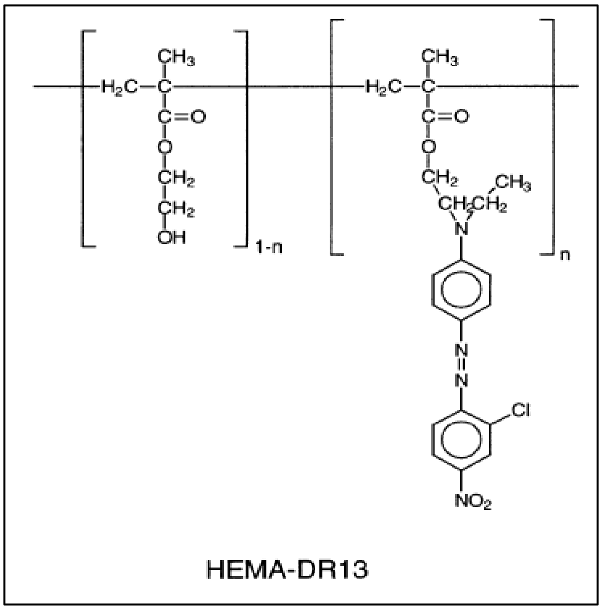

Figure 1. Chemical structure of HEMA - DR13.

Using two lasers, laser He - Ne linearly polarized low power with a wavelength of 632.8nm, and a Nd: YAG laser with a wavelength of 532.8nm and also linearly polarized low power are able to induce the optically birefringence in a microstructured films HEMA - DR13, which were prepared by the deposition method in a saturated atmosphere. Using the optical arrangement shown in figure 2 is able to induce birefringence. The reading laser (He - Ne) is in charge of verifying the state of polarization in which the chromophores are azopolimero through two polarizers which are crossed to each other. When the excitation laser (Nd: YAG) impinges on the sample starts the process, allowing the external electric field provided by the laser passing chromophores excited state so trasn - cis. To make this happen successfully, be careful that the polarization direction of the laser beam is perpendicular to the reading provided by the laser beam writing. As time passes, the chromophore in the sample are aligned parallel to the external electric field of the laser writing [3, 4].

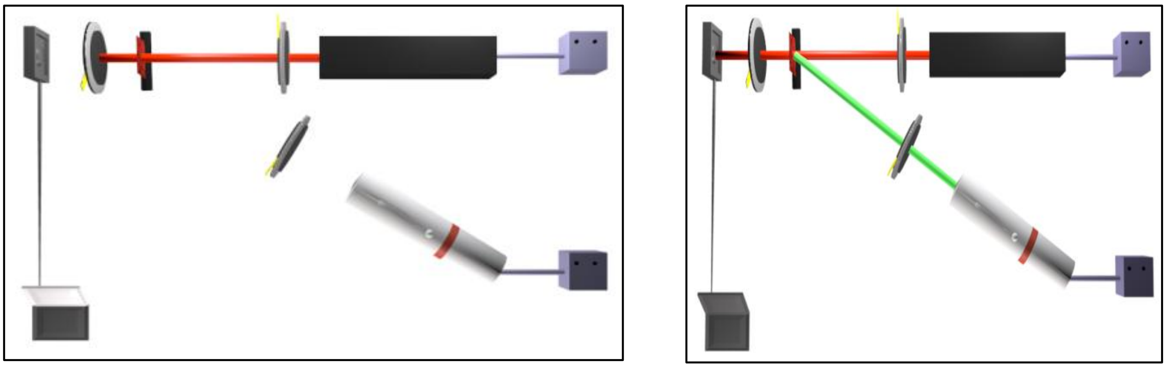

Figure 2. Schematic experimental photo - induced birefringence before and after exciting the sample.

2. Results and discussion

To establish the wavelength of the lasers used, it was necessary to take an absorption spectrum as needed that one of the lasers (the reading) will not affect the state of the chromosphores in the sample, but it was totally "transparent" to it. The result obtained is shown in figure 3, which shows that the spectral range in which the sample absorbs more light corresponds ranging from 520 to 600nm, a range in which is the wavelength of the excitation laser. While the laser reading is outside this range, therefore the specimen is unaffected by this.

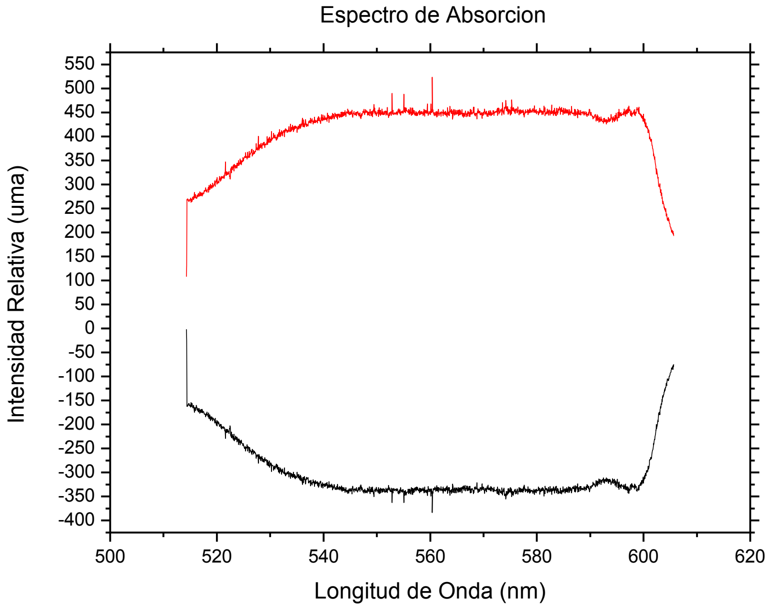

Figure 3. Absorption spectrum of HEMA - DR13, the spectral window in which the phenomenon of photo-isomerization.

The signal obtained was taken with a photodetector with a rise time of 1ns, and Labview a data acquisition card, processed through a pc. The signal obtained for the sample shown in figure 4. It shows the birefringence induced in the sample azopolymer for a 4.5mW power. Clearly shows the rapid increase of the signal, this is the time when the writing laser is incident on the sample, ensuring that the chromophores will begin to move in the polymer layer.

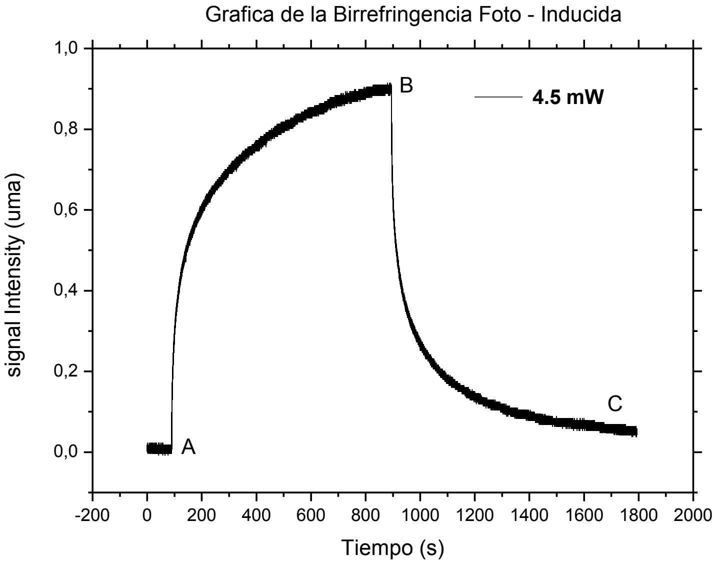

Figure 4. Intensity of the signal obtained for the photo-induced birefringence versus time.

After the same process was performed but varying the write laser power, to obtain the results shown in figure 5.

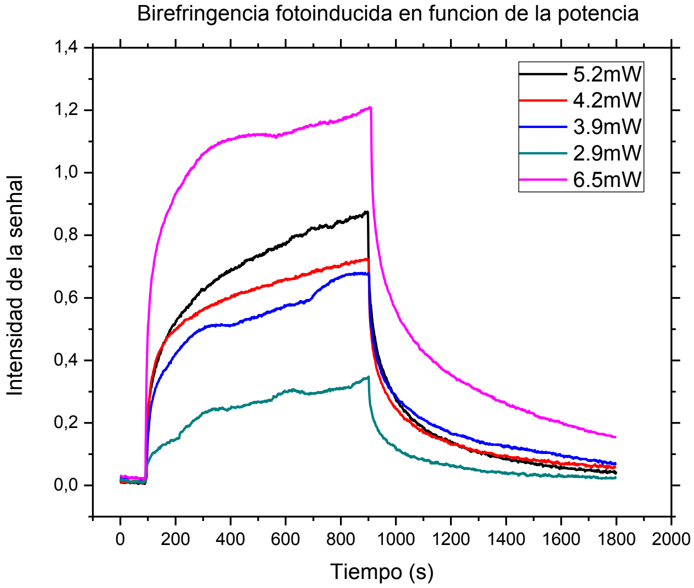

Figure 5. Induced birefringence signal depending on the power.

Clearly shows that as the power increases the signal intensity is increased to approach a maximum value. At this point most of the chromophores present in the sample are in the excited state, the cis state. Immediately remove the chromophores laser writing start state to unwind from cis - trans, showing that the signal strength decreases gradually to its initial value. This process is repeated for each of the samples used. The temperature at which the samples were in the laboratory was 24 °C. the signal strength varies according to the temperature showing that the lower the temperature the higher the birefringence signals.

3. Conclusions

It was possible to obtain an absorption spectrum of the samples prepared by the method of deposition in a saturated atmosphere was achieved which identify the range of absorption of the sample to the utilization of lasers both read and write. Furthermore, the signals obtained for a fixed power birefringence achieving verify and observe the photoisomerisation in the HEMA - DR13 achieving a relaxation time of about half an hour with the quality of this material can be used for optical storage utilization. Furthermore it could be shown that for the variation of the excitation power of the signal intensity variation, noting that between higher the excitation power, the higher the intensity of the photo-induced birefringence.

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