TWO-PHOTON INDUCED BIREFRINGENCE IN SALEN DYE AZO COMPOUNDS FILMS

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Abstract

This work reports the two-photon optically induced birefringence in cast films of a new series of azoaromatic compounds named Salen dyes. This birefringence is caused by trans-cis-trans photoisomerization accompanied by molecular reorientation. When excited by linearly polarized laser light, azobenzene chromophores undergo photoisomerization, which causes birefringence in the films. Recently it has been proposed the use of two-photon absorption process to induced isomerization and consequently molecular reorientation, allowing reversible three-dimensional optical storage.

Samples studied

The Salen Dye´s samples were provide by Dr. James Bu (Clark Atlanta University Atlanta - USA). Fig. 1 displays their molecular structure. The UV-Vis spectrum of the cast films are shown in Fig. 2, which also includes the spectrum for the dyes in a NMP solution. The absorption maximum of the film is blue shifted in comparison to that in solution, indicating H-type aggregation of azobenzene chromophores in the film. Such a behavior is similar to the one observed for other azo polymers.

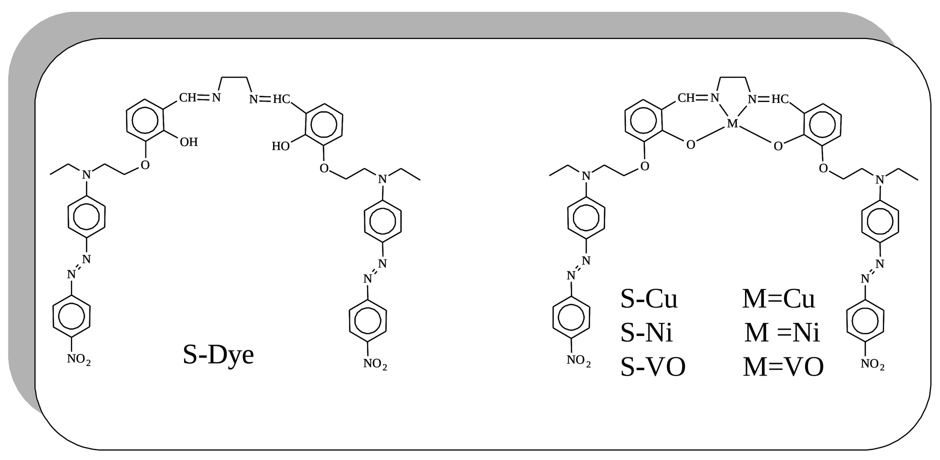

Figure 1 – Molecular structures of the compounds investigated.

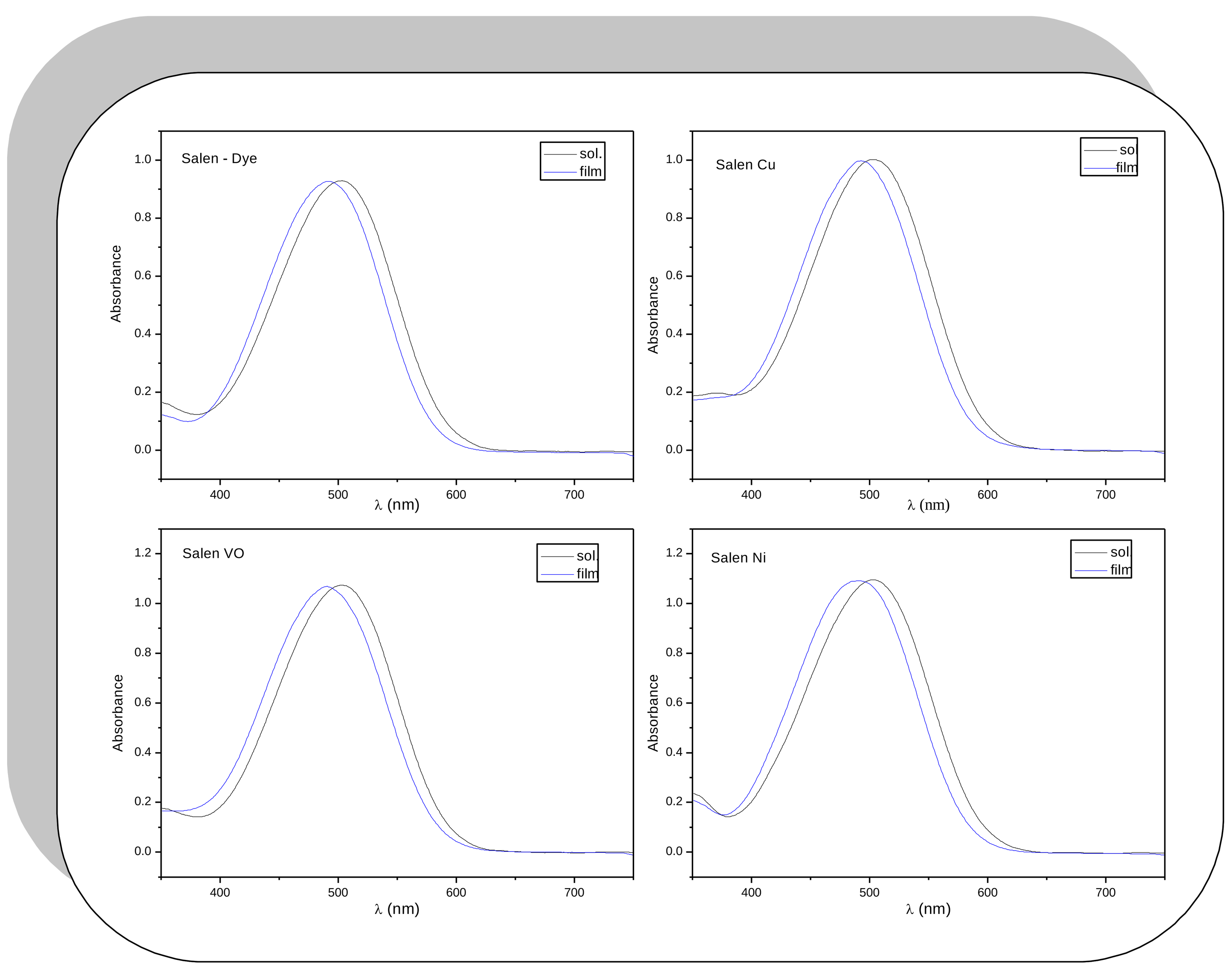

Figure 2 – UV-Vis absorption spectra for the studied samples.

Birefringence Experimental Setup

Azobenzene chromophores when excited by linearly polarized laser light undergo *trans-cis-trans* isomerization, accompanied by molecular reorientation which is corroborated to the induced birefringence into the irradiated region. Figure 3 shows a schematic representation of the orientation process. The two-photon induced optical birefringence were achieved employing 150 fs pulses from a Ti:sapphire chirped pulse amplified system (CPA-2001, from Clark-MXR Inc.) operating at 775 nm with 1 KHz repetition rate and with a polarization angle of 45^0 with respect to the polarization orientation of the probe beam. A low-power He-Ne laser light at 632 nm, passing through crossed polarizes, was used as the reading beam to measure the induced birefringence in the sample. Figure 4 presents a diagram of the experimental setup.

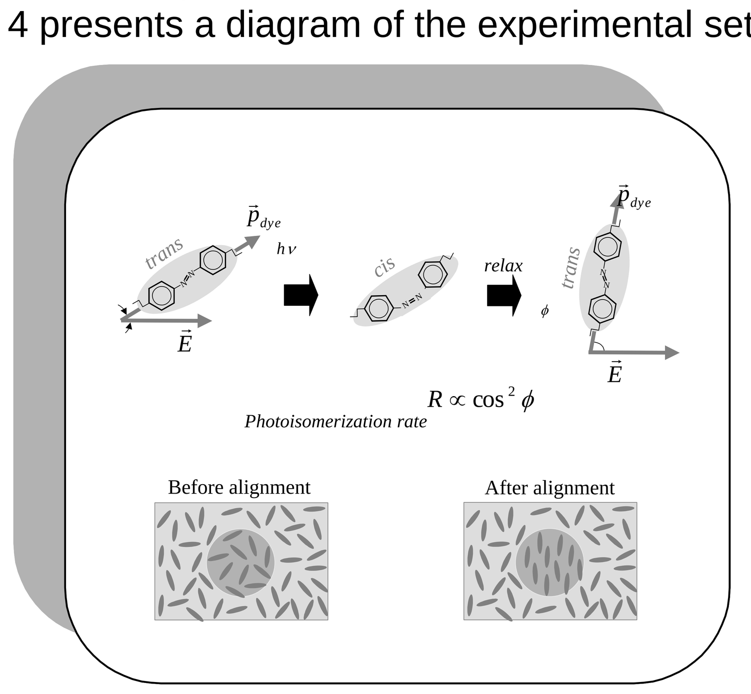

Figure 3 – Optically induced birefringence diagram

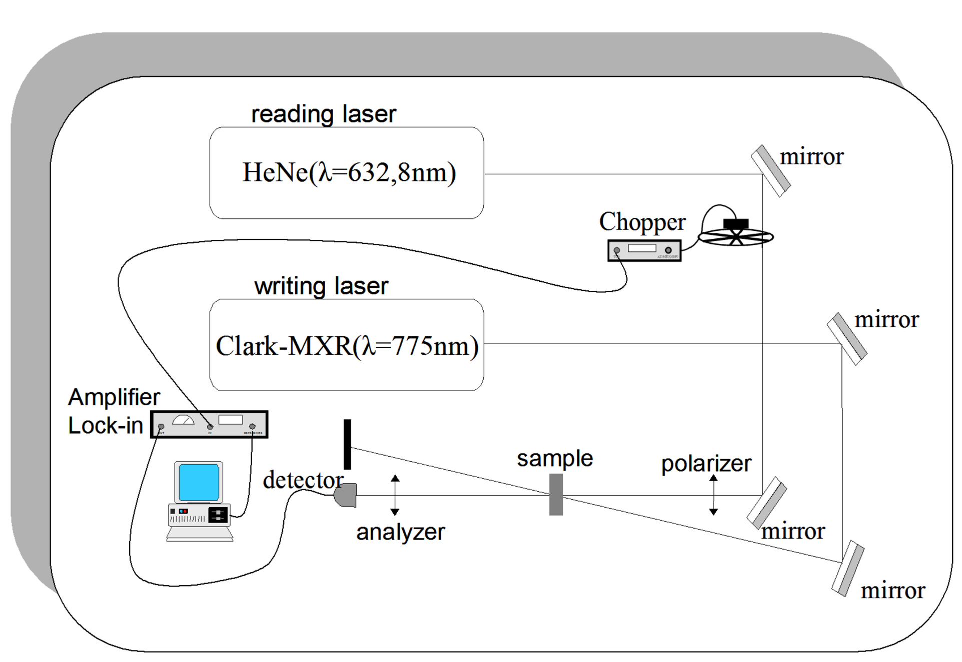

Figure 4 – Birefringence experimental setup.

Results

The result of a typical optical storage experiment with the Salen-dye cast film by one-photon absorption is presented in Fig. 5, in which a writing power of 6.3 mW was used. When the writing beam was switched on at point A, the transmission increased and reached saturation in four minutes. Such an increase in the transmission is related to the induced birefringence due to the chromophore orientation. At point B the writing beam was switched off and the transmission decreased sharply, reducing to about 10% of the saturation value (point C) in about 50 seconds. Figure 6 displays a result with the same film, however it was induced by two photon absorption. As can be seen in Fig. 6, the same characteristics are observed, but the writing time is higher than the one observed for the one-photon induced birefringence.

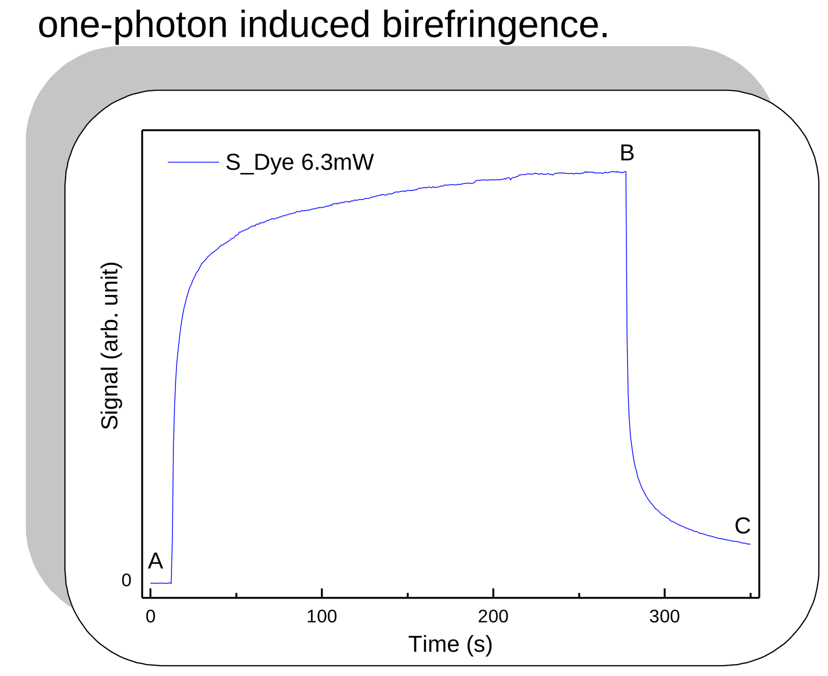

Figure 5 – Writing sequence induced by one photon for the Salen Dye film with a laser power of 6.3 mW.

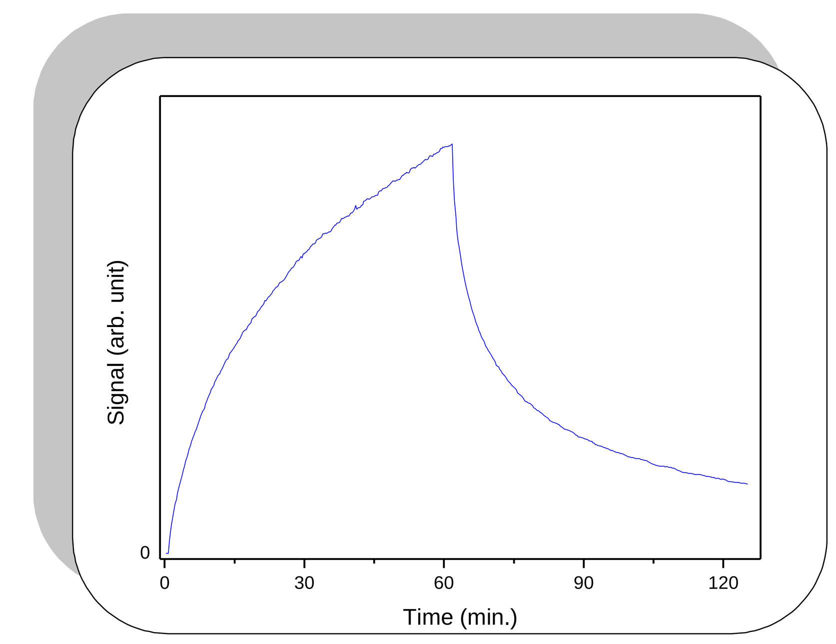

Figure 6 – Writing sequence induced by two photon absorption for the Salen Dye film.

In Fig. 7 we present the writing sequence induced by two-photon absorption obtained using an excitation power of 75 mW for all the samples studied.

In order to demonstrate the nonlinear nature of two-photon induced birefringence, it was measured the maximum transmitted signal as a function of the writing beam power, as showed in Fig. 8.

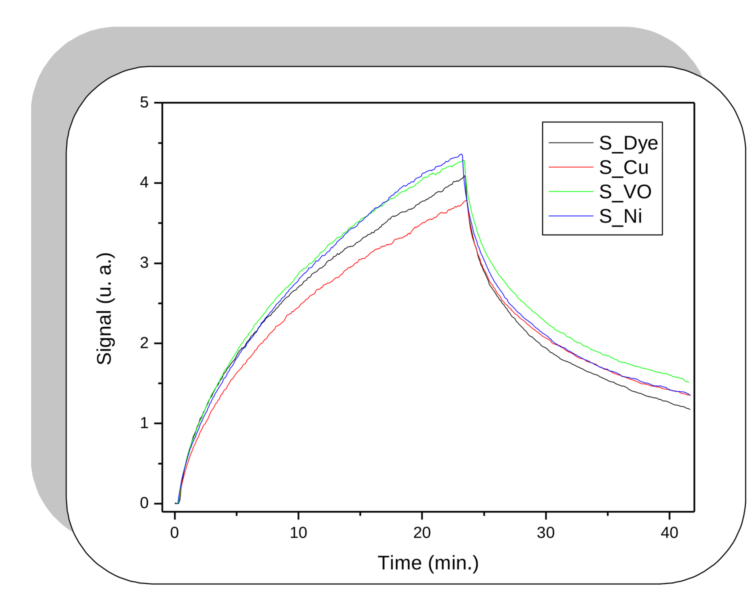

Figure 7 – Writing sequence for the four Salen compounds with a laser power of about 75 mW.

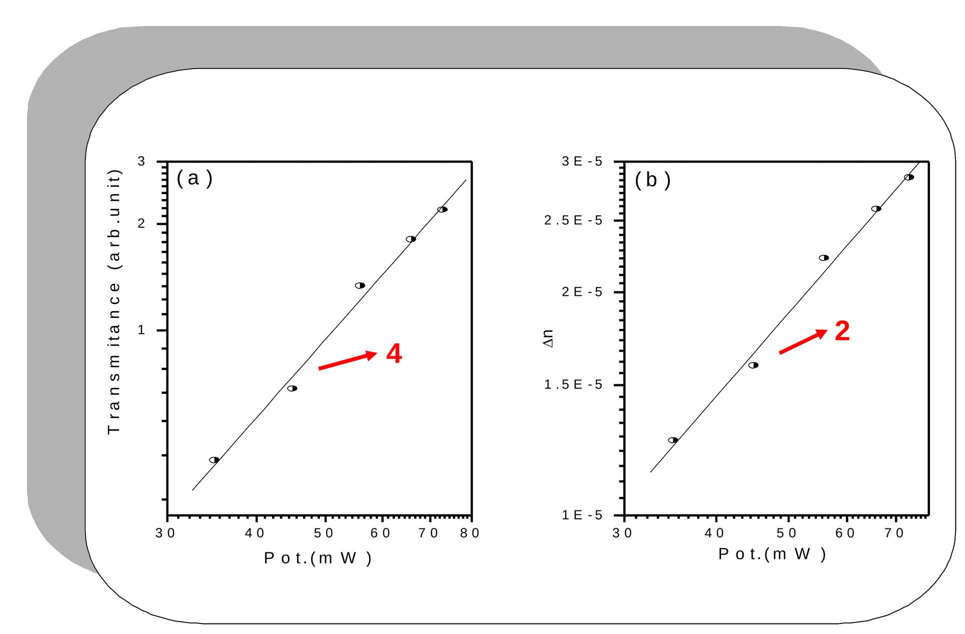

Figure 8 – The changing maximum transmitted signal as a function the writing beam power in 775 nm.

Conclusion

In summary, the results presented here indicates the possibility of using Salen dye in optical storage devices. The two-photon induced birefringence resulted in a residual fraction of optical storage higher than the one observed for the one-photon birefringence. In addition, the two-photon process may be applied in reversible three-dimensional optical storage.

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