External electric field-induced dichroism in solutions of hexadecanoic acid

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Introduction

The polarity of a chemical reagent is important for solvating in specific solvents regarding a rule of thumb that says *like dissolves like*. This involves physical-chemical properties of molecules such as dipole moment, dielectric constant and miscibility with water, which are independently measured by different techniques. Respect to dipole moment, the Stark effect may be used to measure it for those molecules whose rotational spectra can be observed, but for complex molecules the rotational spectra cannot be interpreted and measurements on a liquid solution must be done by different methods[1].

The hexadecanoic acid ($C_{16}H_{32}O_2$), also known as palmitic acid, is a fatty acid separated from vegetable oils obtained from palm fruits. It is one of the many natural products that can be extracted from the palm trees abundant in the Amazon region, with high commercial value for foods[2]. But one of the great limitations for its commercial exploration involves an efficient chemical process of separation by using organic solvents. In this sense, investigations about the dipolar properties of major compounds of vegetable oils may be an important auxiliary tool in separation processes[3].

In this work we intend to characterize the polarizing behavior of hexadecanoic acid diluted in hexane submitted to an external electric field dc as function of time, monitoring the average response of the medium with a weak polarized laser beam. We stress that measurements of dipolar properties of the hexadecanoic acid not has been reported previously, at our knowledgement.

Experiment

The experiment is based on the fact that the dipole orientation of molecules within a transparent medium produces an anisotropy in the medium, which may be monitored by a polarized light beam. The intensity of the transmitted beam decrease when its polarization is perpendicular to the direction of orientation of the dipoles with the external electric field applied. This phenomenon is called polarization by absorption or dichroism.

Figure 1 show the experimental arrangement where a He-Ne laser (632,8 nm) was used to monitor the effect in solutions of hexadecanoic acid solved in hexane when a dc voltage (560 V) was applied between two metallic parallel plates. The applied voltage given rise to an electrical field into the solution perpendicular to the plane of incidence. A Glan-Thompson polarizer prism (GT-prism) was used to select the components of polarization of the laser beam parallel (**p**) or perpendicular (**s**) to the plane of incidence in the sample.

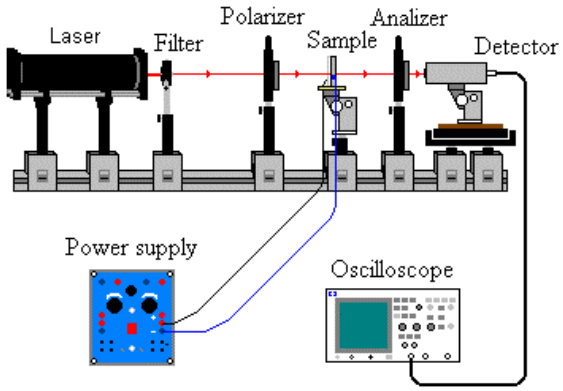


Fig. 1. Experimental setup.

The experimental procedure consist in to measure separately the time dependence on laser intensity for each one of the components of polarization **s** or **p** of the laser beam when the voltage was turned on, at constant room temperature (22^{o}C).

Results and discussions

Figure 2 show the intensities of the laser beam with **p** and **s** polarizations after to cross the sample during 30 minutes. It is observed that **s**-component of the laser beam cross the sample without attenuation, while the **p**-component undergo a decrease after 30 minutes. This indicates that the external electric field applied breakdown the isotropy of the medium giving rise to absorption of the **p**-polarized component of the laser beam. No absorption was observed for both **s** and **p** components of the laser beam when the power supply was turned off.

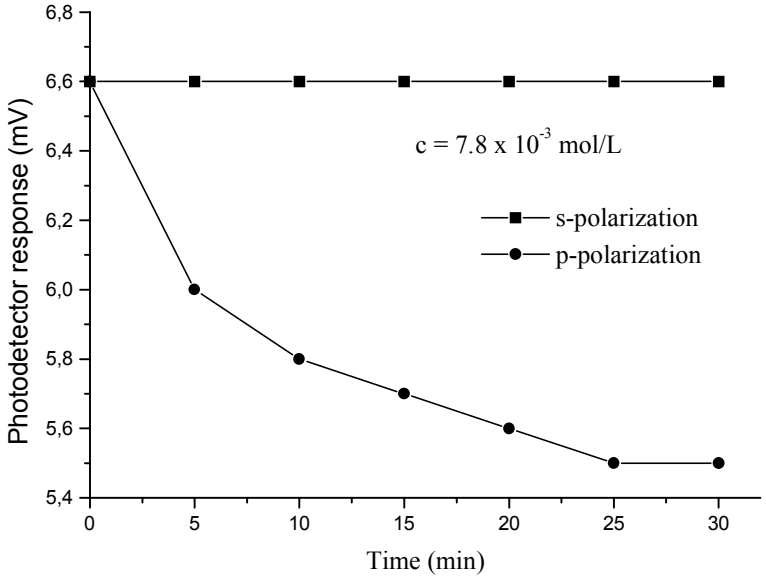
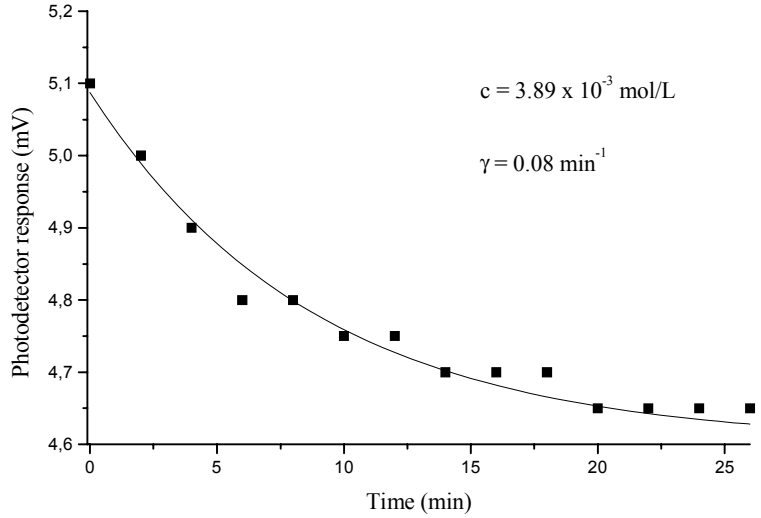
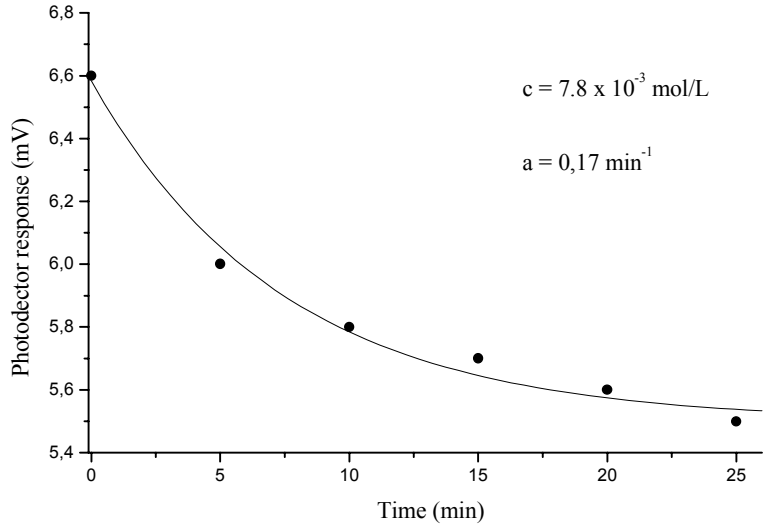


Fig. 2 – Intensity of the **p** and **s** components of the polarized laser beam transmitted through solution of hexadecanoic acid diluted in hexane solvent, when a dc external voltage is applied.

In order to investigate the dependence of the dichroic behavior on concentration of the solution, were performed measurements of the absorption of the **p**-component at $3{,}89 \times 10^{-3}$ mol/L, $7{,}8 \times 10^{-3}$ mol/L and $11{,}6 \times 10^{-3}$ mol/L. The results are shown in the Figure 3 where is observed that by increasing the concentration of the solution increases the absorption of the laser beam. We have made an estimation for the attenuation by fitting the experimental points with an exponential function $I = I_0 \exp(-\gamma t)$, where I_o is the laser beam intensity when the dc voltage is turn off and the γ label represents a coefficient of attenuation measured in reciprocal time (min^{-1}). Figure 3 shown the curve of fit and the estimated values for the γ coefficient increasing from 0.08 min^{-1} to 0.29 min^{-1} by increasing the concentration of the hexadecanoic acid diluted in hexane.





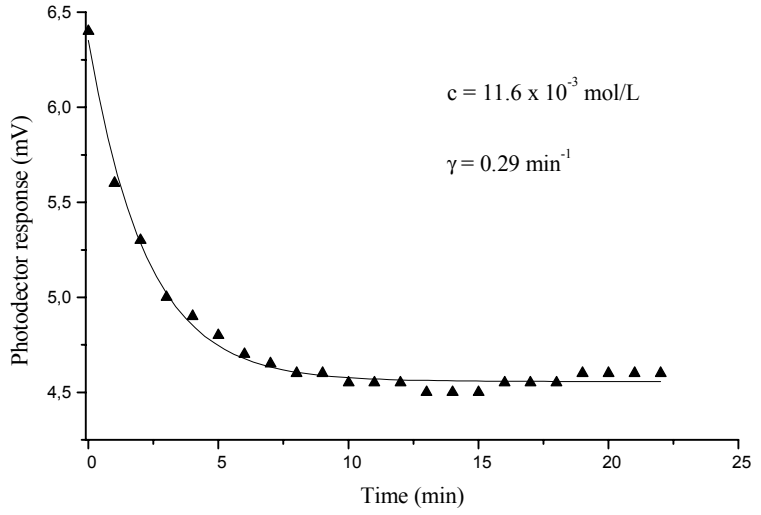


Fig. 3 – Dependence of the absorption of the **p**-polarized light on concentration of the solution.

Fatty acid molecules are complex molecules with large molecular weight and their alignment with an electrical field externally applied may be difficult. This could explain the temporal decrease relative slowly observed in the figures 2 and 3 above.

Conclusions

We reported experiments on average polar properties of a liquid solution containing palmitic acid as chemical reagent solved in hexane. Was verified that this solution may present induced dichroism when submitted to an external electric field. A fitting of the experimental results allows to evaluate a temporal coefficient for absorption depending on concentration. These results may be important as auxiliary tool to separation processes of molecules from vegetable oils.

More investigations concerning to physical properties from other organic compounds found in vegetable oils from the Amazon region are in progress.

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