Electro-optical response in liquid crystal cells obtained in DC polymerization reactor

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In the last decade, the interest in LCD displays has grown considerably.. A key feature in making thhis displays is the refresh rate.. In general, most displays use a refresh rate of 60Hz (once every 16 ms). In this work we present a DC polymerization reactor used to obtain thin duromer films to enhance the electro-optical response of the liquid crystal (LC) and the response time of the LC cells. A comparison between a control sample and LC cells with polyanilline and polypyroll thin films deposited in the polymerization reactor is presented to show how the response rate can be enhanced. The duromer films are analyzed with SEM and AFM to see the morphological structure of the surface before the cells were built. We used a He-Ne laser to analyze the optical response and a function generator in order to polarize the cells. The signal was acquired with a fotodiode and all the data was collected was processed and analyzed.

1. Introduction

Plasma is defined as a cvasineutral electric system formed of charged and neutral particles, photons, and electromagnetic fields having collective behaviour. [1-3]. The technique of obtaining thin polymer films is called plasma polymerization. This technique offers divergent results from those resulting from classical polymerizations. Polymeric films obtained by this method cover a broad field of applications (biocompatible materials, hydrophobic films for optical applications, wear resistant films, etc.) [4]

In this paper we present the electro-optical response in liquid crystal cells obtained by deposition of thin duromer films. The results were compared with a control sample with no polymer film deposited. The response rate as well as the optical transmission are showed.

2. Experimental setup

2.1 DC plasma polymerization reactor

For the investigation on how the different parameters of the plasma and the position of the substrate inside the discharge can affect and modify the morphology of a thin duromer film, a reactor was built with the possibility of changing the geometry and important deposition parameters. [4,5]

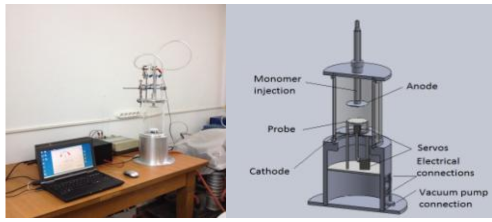
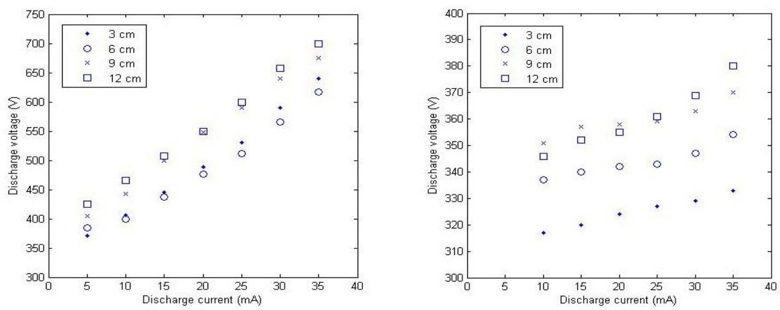


Fig.1 DC polymerization reactor

One of the most important aspect in the deposition method is the use of small electrical currents in the discharge. This fact ensures low temperatures for the plasma constituents. [4]



a) 0.1 Pa b) 1Pa

Fig.3 Voltage-current characteristic in stationary mode

2.2 Electro-optical measurement

Electro-optical response as well as transmission were measured using a He-Ne 633nm laser as a radiation source, a photodiode with amplification to measure the transmitted light, TTI 50MHz Function Generator to polarize the liquid crystal cell and a GWINSTEK GDS-2104 Oscilloscope to measure the electro-optical response in accordance with the polarized state. All of the devices were connected to a computer to ensure an automated measurement system.

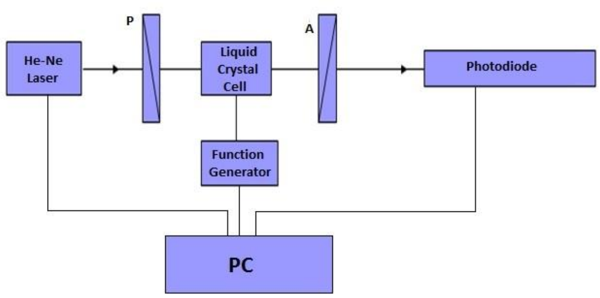
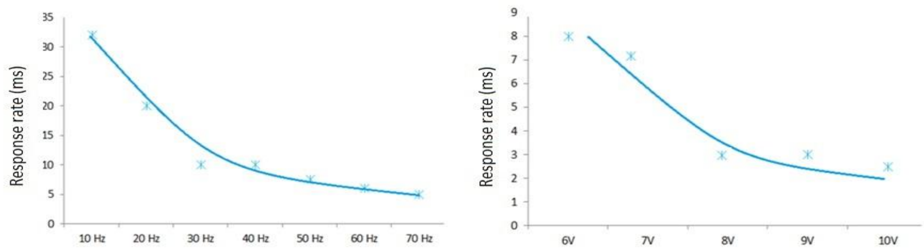


Fig. 4 Schematic representation of electro-optic measurement

The measurements were perform in order to see how the light reacts to the different polarization states in the cell. Actual value of birefringence depends directly on the orientation of liquid crystal molecules in the cell. The value of birefringence is zero when all the liquid crystal molecules are oriented normal to the surface (homeotropic configuration). The application of an external electric field (AC), the molecular director undergoes a shift, which creates a variation of birefringence. [5]

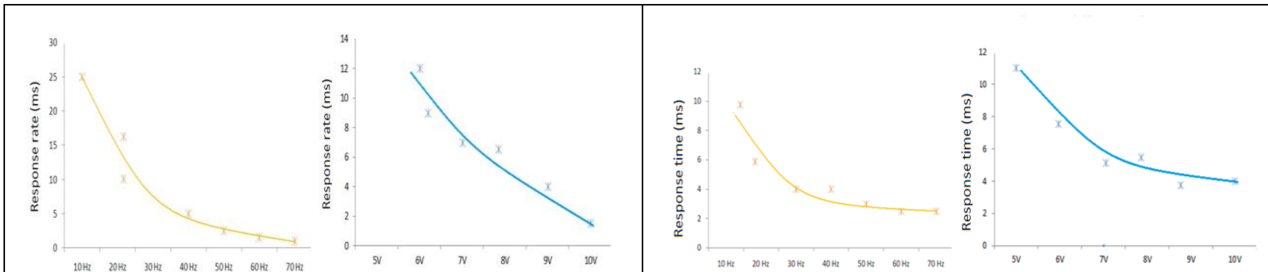
3. Experimental results

The experimental results refer to the measurement of 3 types of liquid crystal cells: control sample, symmetric polyaniline cell and asymmetric polypirole cell. The electro-optic response and the transmisivity has been measured for polarization voltages between 1-10V and frequencies between 10-70Hz. For the control sample we show a response rate of 5 ms at 9V (Fig. 5 a)) and 2.5 ms at a frequency of 60Hz (Fig.5 b)).



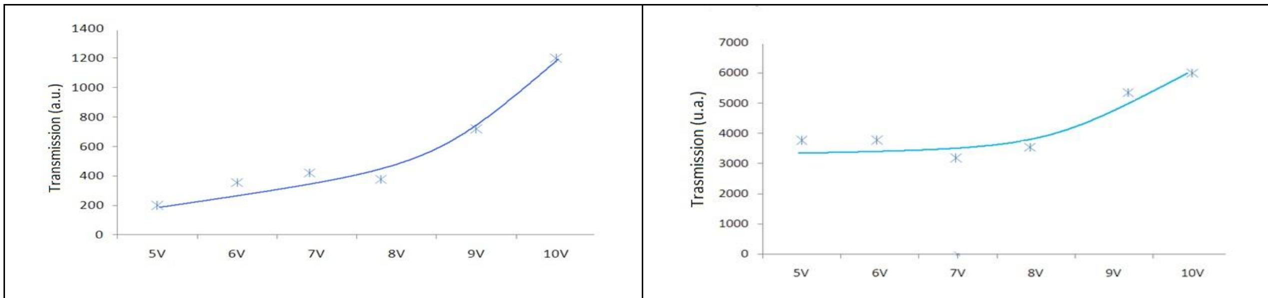
a) b)

Fig.5 Control sample response rate at 9V (Fig. 6 a)) and 60Hz (Fig.6 b)).



a) Asymmetric polypirolle cell	b) Symmetric polypirolle cell

Fig. 6 Asymmetric polypirolle (a) and Symmetric polypirolle (b) cell response rate at 10V and 60Hz



a) Asymmetric polypirolle cell	b) Symmetric polypirolle cell

Fig.7 Asymmetric polypirolle (a) and Symmetric polypirolle (b) transmisivity at 70Hz

In the case of asymmetric polypirolle cell, at a frequency of 70Hz and 10V, the electro-optic response was lower than 1 ms. The transmission was greater than in the case of the control sample by as much as 40%.

For the symmetric polyaniline cell, the response rate is not as good as in the case of polyporolle cell but is still better than the control sample. The high transmisivity of the polyanilline cell is almost 6 times bigger than the assymetric polypirolle cell. [5]

4. Conclusions

We successfully deposited structured duromer films using DC polymerization reactor for the use in building of liquid crystal cells with grater response rates. The result show an increase in response rate (< 1ms) and an increase in transmission of more than 35% (1200 a.u. for the asymmetric pyrrole cell and 750 a.u. for the control sample). The best transmission was obtained by the symmetric aniline cell (7000 a.u.), more than double than the control sample (3000 a.u.).

The thin duromer films obtained by plasma polymerization for the use in liquid crystal cells offers the possibility of improving the performance. New research is still under way to understand the mechanisms in how the liquid crystal anchors itself to the duromer film in the hope to further increase the electro-optic proprieties.

5. References

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