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Optical Study of the DNA in the Liquid Crystal

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Abstract

The microscopic and laser study of the DNA in the liquid crystal media have been shown. Self-arrangement effect and the increase of the laser-induced refractive index have been postulated.

Keywords: Liquid crystal media; DNA; Self-arrangement; Refractivity change; Optics of the organics; Laser-matter interaction

Introduction

At present time the extensive development of the general optoelectronics instruments, laser and display technologies, biomedicine devices, etc. has stimulated the detailed investigations aimed at increasing the performance of optical elements. An important aspect of this work is the development, synthesis, and characterization of new materials doped with the nano or bio-molecules. Among the different class of the organic materials, the liquid crystals (LC) have the special place due to their important orienting ability, which is used in creating composite materials [1-3]. In the current paper the brief analysis of the optical study of the nematic LC doped with the bio-molecules based on the red fish DNA is postulated.

Experimental conditions

The nematic liquid crystals (NLCs) belonging to the class of cyanobiphenyls have been used as the matrixes. The LC samples have been sensitized by the DNA. The samples were sandwich cells with dimensions of 25-25 mm and a gap width of 10 mm. Content of DNA (from salmon fish) in the water solution was ~4.72 g×L^{-1}, and the relation between LC and DNA was ~5:1. Microscopic study of the composites materials have been made using POLAM-P312 polarizing microscopy, ellipsometer Horiba Jobin Yvon Uvisel. Refractive experiments have been made using holographic technique based on the four-wave mixing technique [4] operated with the nanosecond pulsed Nd-laser with the second harmonic convertor (wavelength of 532 nm) working at the different spatial frequency at the energy density range of 0.01-0.5 J×cm^{-2}.

Results and Short Discussion

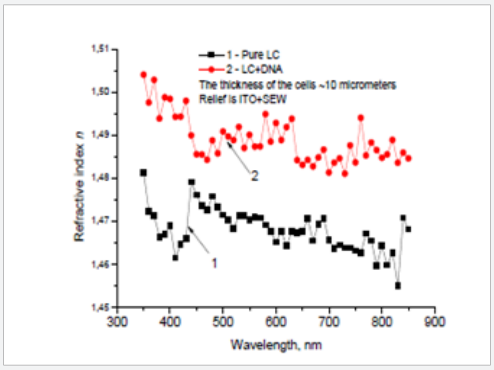

Figure1: Refractive index change of the pure LC and of the LC with DNA.

The data of the refractive properties study of the LC-DNA composites obtained both via classical ellipsometry method and via holographic recording technique is shown in Figure 1 and in Table 1. It should be mentioned that when the LC-DNA composites have been studied the novel method to make the relief to orient the LC-molecules has been used. It is based not on the rubbing technique but connected with the surface electromagnetic wave (SEW) treatment of the ITO conducting layers coated by the carbon nanotubes. Briefly this method has been explained in the paper [5].

Table 1: Laser-induced change of the refractive index Δn_i of the doped LC treated at the same spatial frequency.

Nos	Structure Studied	Nano-Object Content wt.%	Energy Density, Jcm^{-2}	Δni
1	Pure LC			$\sim 10^{-4}$
2	LC+dyes			$0.16*10^{-3}$
3	LC+complex (Polyimide+C_{70})	0.2	0.1-0.3	$1.2*10^{-3}$
4	LC+complex (COANP+C_{70})			$1.4*10^{-3}$
5	LC+DNA	0.1	0.1	$1.39*10^{-3}$
6	LC+DNA	0.05	0.1	$1.1*10^{-3}$
7	LC+QDs CdSe(ZnS)+DNA	0.1	0.1	$1.35*10^{-3}$

To analyze the refractive processes using laser technique one should take into account that when the electric field of the laser wave is less than the intra-atomic electric field correlated with the electron charge and with the Bohr radius, we should estimate the linear effect. But, when the electric field of the laser wave is larger than the intra-atomic electric field, we should draw the attention on the nonlinear optical features. Using this aspect, the values of optical susceptibility play important role in nonlinear optical effect. Really, the most important optical characteristic of the all inorganic or organic materials with different symmetry is the induced dipole, whose can be expressed through dipole polarizabilities $\alpha^{(n)}$. These are in turn related by the proportional dependence to the nonlinear susceptibility $\gamma^{(n)}$ and to the local volume υ of the materials (media). Thus, laser-matter interaction provokes the change in polarization of media [6] and predicts the change in important properties, such as dynamic, photoconductive and photorefractive ones.

The laser-induced change of the refractive index Δn_i has been calculated from the diffraction efficiency η [6,7] via realization of the Raman-Nath diffraction conditions (Λ^{-1}>d) using the equation (1):

$$\eta = \frac{I_1}{I_0} = \left(\frac{\pi \Delta n_i \mathrm{d}}{2\lambda}\right)^2$$

Here Δn_i – induced change of the refractive index, I_1 is the intensity in the first diffraction order, I_0 is the input laser intensity, d is the thickness of the medium, λ is the wavelength of the light incident on the medium, Λ is the spatial frequency. Thus, using the explanation and the procedure mentioned above, one can postulate that the nano-and bio-molecules doped LC can provoke the same refractive parameters. But, taken into account that the bio-objects as the effective dopant can be found from the Word Ocean and they are non-toxic, the bio objects have some advantage in the comparison with the nano-objects ones.

Conclusion

To summarize the results, it should be concluded:

a. LC mesophase can play the special role in the material science and technology due to the fact that the LC media provoke the orientation of the nano- and bio-molecules with good advantage. It permits to test, to calculate the number, to visualize the form, etc. of the included bio-particles.

b. Optical study of the organics, specially the LC ones have the good advantage due to the fact that LC is water soluble materials and can save the living ability of the bio-objects.

c. It has been established that the non-toxic renewable bio-particles influence on the photorefractive features of the organic LC conjugated matrixes close to how the nano-objects effect. It extends the area of the optoelectronic and biomedicine application.

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References

1. Elena Ouskova, Jaana Vapaavuori, Matti Kaivola (2011) Self-orienting liquid crystal doped with polymer-azo-dye complex. Optical Materials Express 1(8): 1463-1470.
2. Nawel Ould-Moussa, Christophe Blanc, Camilo Zamora-Ledezma, Oleg D Lavrentovich, Ivan I Smalyukh, et al. (2013) Dispersion and orientation of single-walled carbon nanotubes in a chromonic liquid crystal. Liquid Crystals 40(12): 1628-1635.
3. Kamanina NV (2002) Optical investigations of a C_{70}-doped 2-cyclooctylamino-5-nitropyridine– liquid crystal system. Journal of Optics A: Pure and Applied Optics 4(5): 571-574.
4. Kamanina NV, Vasilenko NA (1997) Influence of operating conditions and of interface properties on dynamic characteristics of liquid-crystal spatial light modulators. Optical and Quantum Electron 29(1): 1-9.
5. Kamanina NV, Vasilyev P Ya, Studeonov (2011) Features of Nanostructured Coatings Obtained by Laser Deposition of Carbon Nanotubes. Technical Physics Letters 37(2): 106-108.
6. Kamanina NV (2005) Fullerene-dispersed nematic liquid crystal structures: dynamic characteristics and self-organization processes. Physics-Uspekhi 48(4): 419-427.
7. Kamanina NV, Uskokovic DP (2008) Refractive Index of Organic Systems Doped with Nano-Objects. Materials and Manufacturing Processes 23(6): 552-556.

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