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LIQUID CRYSTAL MATERIALS WITH REGULATED OPTICAL PROPERTIES

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Abstract. *In this work we present the results of structural and electrooptical investigations of the new-created composites based on lyotropic liquid crystals (LLC) of potassium caprylate and viologens. Provided structural analysis showed the presence of a Smectic ordering in the investigated samples and allowed to determine its main parameters. It was shown that the electrochromic properties of viologens are preserved after their solution in the liquid-crystalline matrix. They reveal themselves as a coloration of the samples under applying of an electric field and are proved by the optical absorption spectra. Also we analyzed the processes taking place in LLC-viologen composites in the case of an electric field applying.*

Keywords: lyotropic liquid crystals; viologens; structural analysis; electrochromism; electronic spectra.

Introduction

The idea of creation of new liquid crystal materials with regulated optical properties lays in doping lyotropic liquid crystals (LLC) with photo- and electrochromic admixtures. Molecules that belong to the class of viologens obtain needed properties, e.g. they are able to change their colour in the case of ultraviolet radiation or external electric field application [1]. These properties remain completely at solving viologens in different solutions. Thus, the same result should be observed at solving viologens in water-containing LLC. High viscosity of LLC might facilitate the prolongation of coloured states lifetime in comparison with the liquid solvents.

Analysis of investigations and publications

Liquid crystals investigations are in the first line of research in the field of display and optoelectronic technologies. Such investigations are particularly effective and acknowledged in the area of thermotropic and polymeric liquid crystals. As for the lyotropic liquid crystals, it should be mentioned that these materials are not used so widely and their investigations are still not full. However, there is a set of articles [2–4] devoted to the investigations of impurity LLC, whose mesophases gain new optical properties peculiar to the admixture materials.

The aim of the present work lays in following:

– creation of electrochromic composites based on lyotropic liquid crystals and species of viologens class;

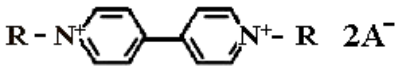
– developing working cells for studying the created materials;

– ascertainment the structure of the LLC-viologen composites;

– realization of complex investigations with purpose to reveal electrooptical properties of LLC-viologen systems.

Materials and methods

Lyotropic liquid crystalline phase was formed at mixing powder of a Potassium caprylate ($C_7H_{15}COO^-K^+$) with water in 1:1 weight proportion at the room temperature (T = 293 K). Then samples of LLC were doped by the viologens of two types: the first one N,N'-diheptyl-4,4'-dipyridilium dibromide ($HD^{2+}2Br^-$), and the second one is N,N'-di(2-carboxyethil)-4,4'-dipyridilium dichloride ($CED^{2+}2Cl^-$). The viologens differ in substitutes at Nitrogen atoms and counterions. The general structural formula for both viologens is given as:



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where R is a substitute, A^- is a counterion. In the case of $HD^{2+}2Br^-$ $R = C_7H_{15}$, $A^- = Br^-$; for the $CED^{2+}2Cl^-$ $R = (CH_2)_2COOH$, $A^- = Cl^-$. Viologens content in the samples amounts to 2 % by weight.

Sandwich cells (fig. 1) were used for the investigation of the created samples. Samples were placed between two glass plates whose inner surface was covered with ITO electrodes. Then the plates were fastened and pasted together to avoid air access and further spoiling of the samples. The thickness of the sample was set with using teflon pads. The voltage was applied using constant voltage source.

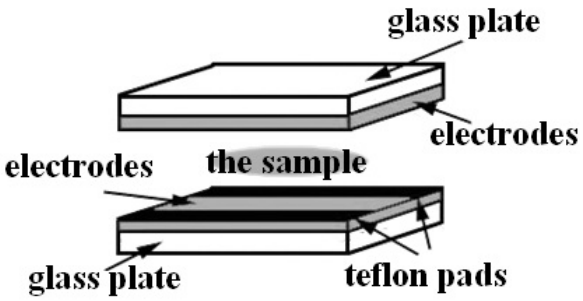

Fig. 1. The experimental sandwich-cell