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MECHANISM OF OPTICAL NONLINEARITY IN "LYOTROPIC LIQUID CRYSTAL — VIOLOGEN" SYSTEM

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Abstract. *In the present work we analyze the characteristics of holographic grating recording and consider a mechanism of optical nonlinearity in the lyotropic liquid crystal (LLC) — viologen samples. Taking into account structural and electrooptical properties of the admixture molecules it is possible to suggest that the recording is realized due to the change of polarizability of π-electron system of coloured viologen derivatives under the action of laser radiation. The main nonlinear optical parameters such as nonlinear refraction coefficient n2, cubic nonlinear susceptibility χ(3), and hyperpolarizability γ were calculated.*

Keywords: diffraction efficiency; lyotropic liquid crystals; nonlinear optics; polarizability; viologens.

1. Introduction

The diffraction grating recording on LLC-viologen composites was realized and investigated in the works [1, 2].

Registered values of the diffraction efficiency in a self-diffraction regime considerably exceeded the residual thermal gratings efficiency. Accordingly, the mechanism of holographic recording in LLC-viologen samples couldn't be explained by a thermal nonlinearity which is peculiar to the most liquid crystalline materials. Most likely it relates to nonlinear effects taking place in admixture molecules.

2. Analysis of investigations and publications

Nonlinear optical properties of liquid crystal materials appear in the case of absorptive mediums and relate to the action of laser radiation on absorptive centers.

In the work [5] diffraction grating recording on the samples of smectic glasses of Cobalt alkanoates is explained by a laser-induced nonlinear polarizability of π-electrons of carboxyl groups of Cobalt complexes. Investigated nonlinear optical properties and holographic recording in bilayer cells "lyotropic ionic liquid crystal — polymethine dye" are caused by resonance nonlinearity [4].

The **aim** of the present work is to clarify the mechanism of optical nonlinearity and holographic recording for the samples of lyotropic liquid crystal with viologen admixtures, and to determine main nonlinear optical parameters of the investigated samples.

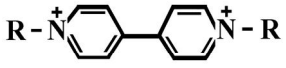
3. Materials and methods

Lyotropic liquid crystal was formed when mixing powder of a Potassium caprylate with water in 1:1 weight proportion was doped by admixtures of two types of viologens: $HD^{2+}2Br^{-}$ and $CED^{2+}2Cl^{-}$. The viologens differ in substitutes at Nitrogen atoms and counterions [1]. Viologen content in the samples came to 2% by weight.

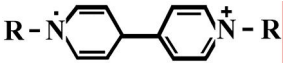
It is determined [1] that an external electric field application to the cells filled with LLC-viologen composite leads to the colouration of the samples, which is caused by viologens reduction near cathode. As a result initially homogeneous samples undergo a separation into a coloured layer of viologen reduction products and a liquid crystal layer.

Depending on the value of an applied electric field viologen molecules could be found in three forms:

— viologen dication (U = 0 V, sample is colourless):



— radical cation (U = 2–2,5 V, sample is blue), formed by one-electron reduction of the initial dication:



— dimer (U = 4 V, sample is red).

Dimerization with equal probability could pass in two ways: after the interaction between the initial