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ABSTRACT OF DOCTORAL THESIS

Optimization of liquid crystal structures used as active optical components in holographic data processing

The aim of the study was to optimize hybrid liquid crystal structures, used as active elements in the holographic optical data processing. This objective was realized through:

- The development, characterization and optimization of the new holographic materials based on LC hybrid systems doped with photoactive nanoparticles of metals and semiconductors.
- To explain the molecular mechanisms of photorefractive effect in doped and undoped LC systems.
- Development of a mathematical model describing the photorefraction phenomenon observed in LC systems.
- Optimization of the performance and response time of LC systems by doping with semiconductor and metallic nanostructures.
- Optimization of performance and response time of LC systems by defining the optimal geometric configuration of the experimental set up.
- Develop practical application of the investigated LC systems.

As part of this research two mathematical models have been proposed. The first model describes and explains the phenomenon of photorefraction in hybrid liquid crystal systems. It relates to surface phenomena occurring at the interface between the photoconductive polymer layer with a layer of liquid crystal, and phenomena taking place in a volume of the liquid crystal, such as the generation of electric charges, the drift or diffusion. The second model is an extension of the first one. It describes and explains the effects of the interaction of the liquid crystal molecules with quantum dots, introduced to its volume.

Research on liquid crystal holographic materials was carried out in three stages. At the first stage, the study focused on development of general mathematical model describing the phenomenon of photorefraction in investigated systems, the aim of which was to optimize material and process parameters. The first attempts to improve the photorefractive effect efficiency, were done by introduction of photoactive nanoparticles of metallic gold and semiconductor quantum dots of cadmium selenide and sulfide. The best results were obtained for the systems doped with quantum dots, therefore the topic was continued on the second stage of research, where the author focused on the practical use of doped liquid crystal systems. Research on diffraction efficiency improvement was continued on the third stage of the study, where effect of nanoparticle absorption maximum was investigated. The conclustions obtained in a degenerated two waves mixing experiment were confirmed with experiment conducted using an optical Kerr effect.

The result of the study was to increase the efficiency of LC systems by means of doping them with semiconductor and metallic nanoparticles. The response time of LC structures are further optimized by determining the optimal geometric configuration of the experimental set up. The final stage of the research was to design and use of prototype of coherence meter and the prototype of

light pulses duration meter based on hybrid liquid structures, which confirms that the objectives of the thesis have been achieved.