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ORGANIC NANOSTRUCTURES FOR THE CREATION OF SENSITIVE ELEMENTS OF EXPLOSIVE SUBSTANCES

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INTRODUCTION

In the modern world, the threat of military conflicts is constantly increasing, as a result of which the problem of detecting ultra-low quantities of explosives at a distance or in difficult conditions is becoming an urgent problem. The detection of traces of explosives is actively researched by scientists [1]. A serious danger is created by explosive substances, in particular RDX (hexogen), PETN (penthrite), NG (nitroglycerine), TNT (trinitrotoluene), and NMH (octogen), most of which contain nitro groups. Therefore, many known detection methods are not aimed at finding specifically explosive substances, but at groups containing nitrogen.[2]

On the basis of known liquid crystal materials with a wide temperature range of mesophase existence and a stable spiral pitch, new liquid crystalline mixtures based on E7 nematic and CB15 cholesteric impurity, doped with single-double and multi-walled nanotubes were created. The concentration of nanotubes is up to 0.7%. Obtained spectral characteristics of mixtures doped with nanotubes, which are characterized by a minimum transmission at a length of 600 nm, and shifts to the long-wavelength region with an increase in the concentration of substances containing nitro groups. These mixtures can be used as a sensitive element of sensors for detecting explosive substances.

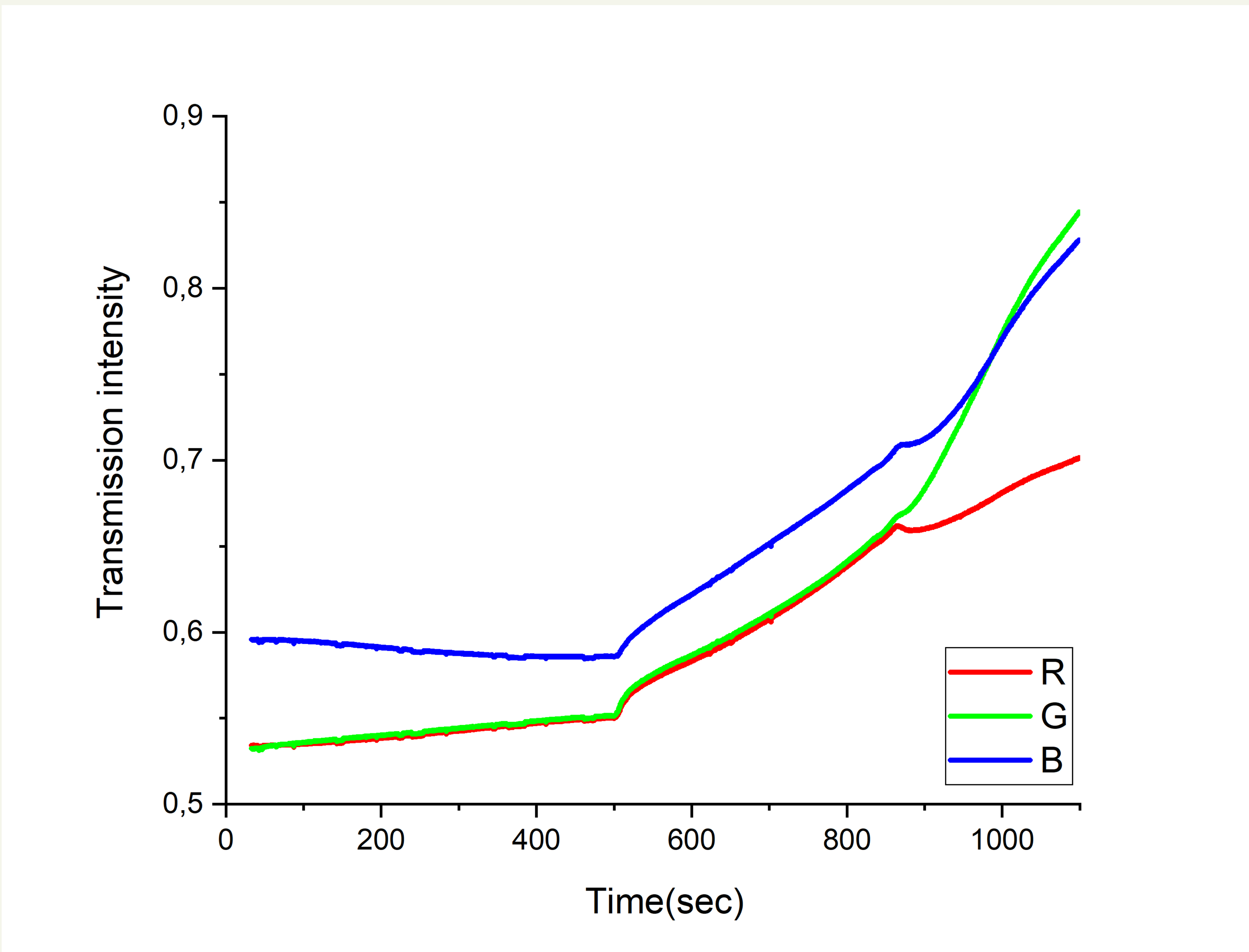


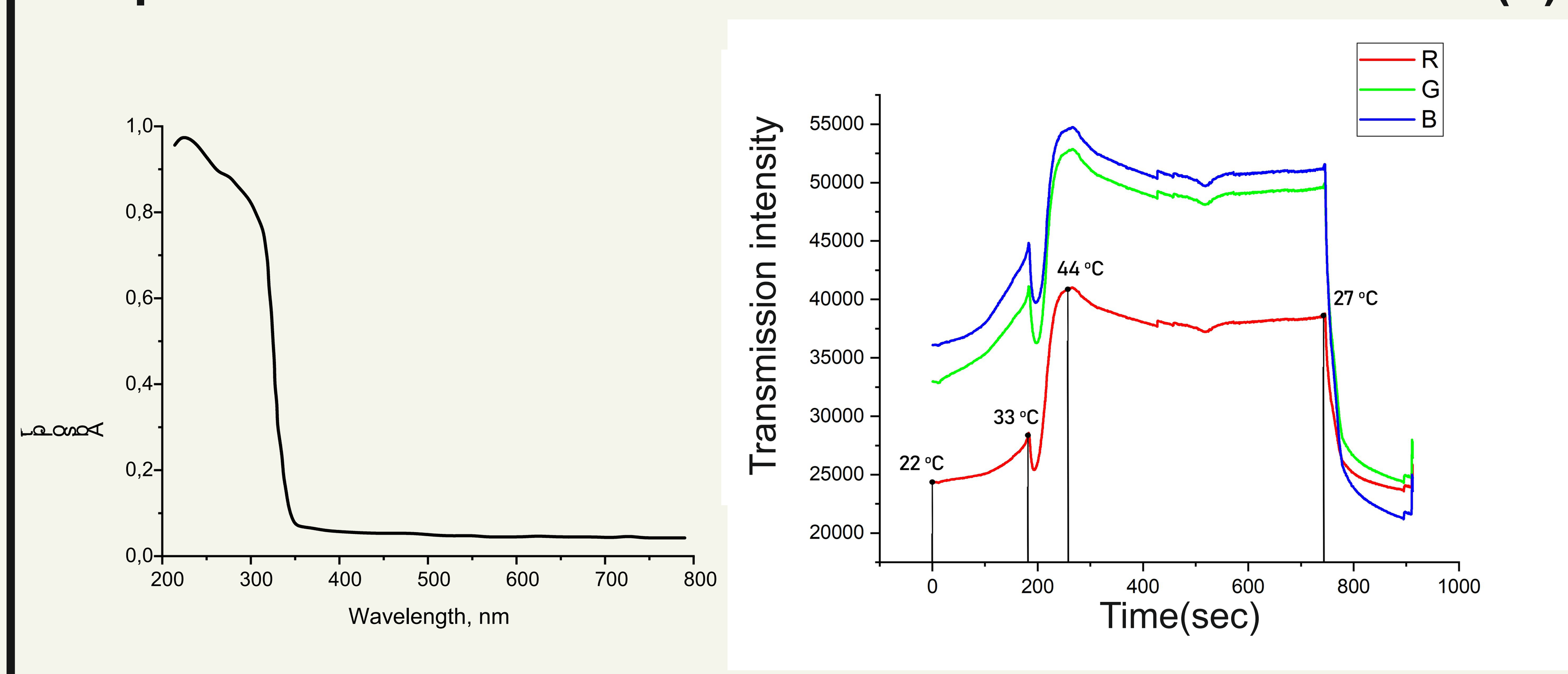
Fig. 2 The interaction of the mixture E7+CB15 38% doped with nanotubes with NO_2

METHODS AND RESULTS

The preparation of experimental nanocomposites began with the weighing of their individual components. To obtain the appropriate weight concentrations of the substances included in the suspension, they were weighed using an electronic scale with an accuracy of 0.0001 in compliance with all requirements for weighing bulk and liquid substances.

The first stage of the creation of the studied nanocomposites consisted in adding a nematic liquid to the cholesteric liquid crystal to form a cholesteric-nematic mixture. The concentration of the cholesteric impurity was selected to obtain the maximum selective reflection in the visible region and varied from 38 to 44%. Experimental compositions were obtained by heating the components to a temperature that is several degrees higher than the temperature of the phase transition to the isotropic state. The mixture was stirred using a magnetic stirrer. This temperature was maintained for 1 hour with periodic mixing of the samples. Experimental cholesteric-nematic mixtures were obtained in

Fig. 1 Spectral characteristics of nematic mixture E7 (a); Temperature characteristics of the mixture E7+38% CB 15 (b)



a) b)

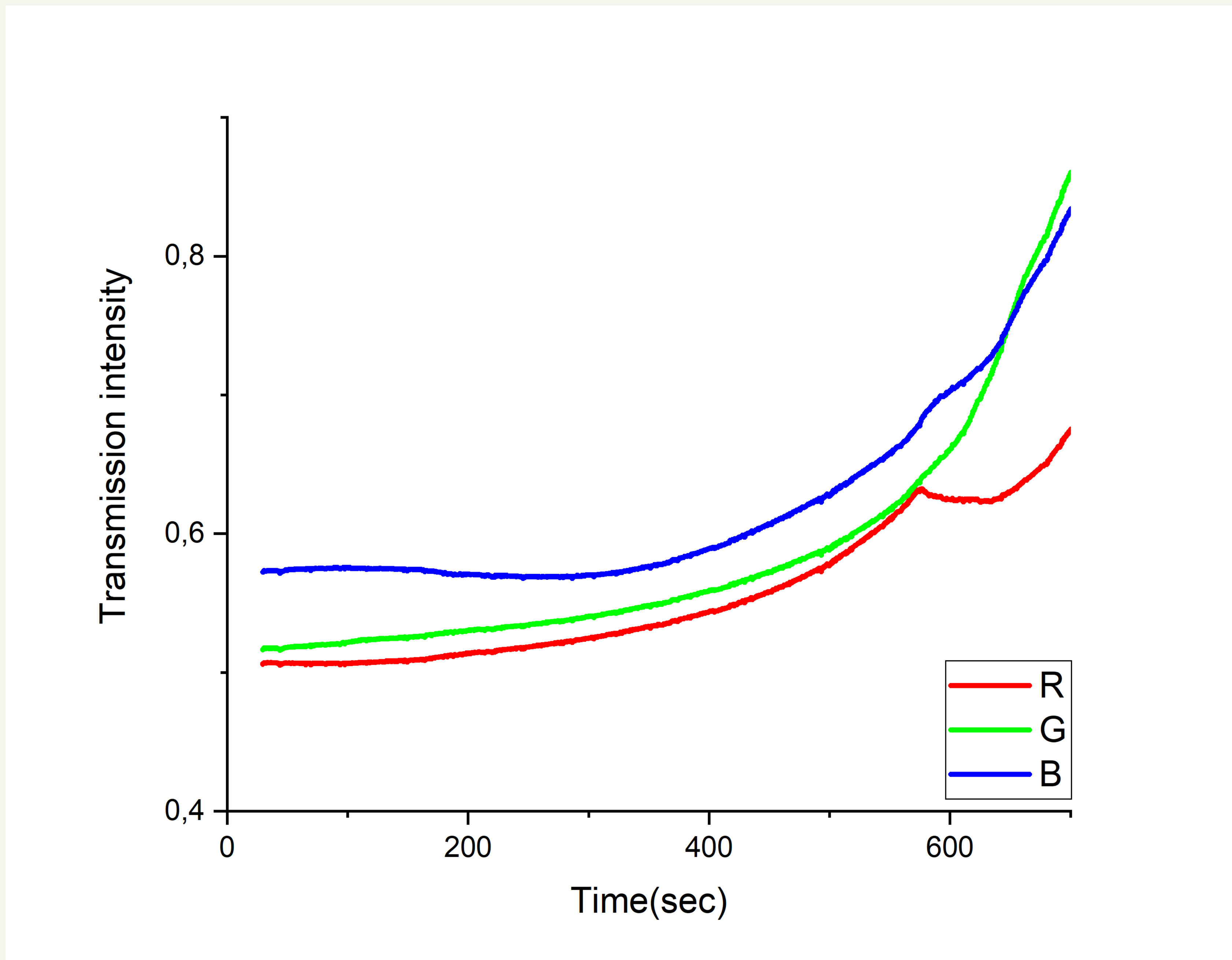


Fig. 3 The interaction of the mixture E7+CB15 44% doped with nanotubes with NO_2

To obtain a homogeneous suspension, nanotubes were introduced into the cholesteric nematic mixture in the isotropic phase with subsequent mixing in an ultrasonic bath for an hour. Effective mixing of nanotubes with a cholesteric-nematic mixture was observed precisely in the isotropic phase of liquid crystals.

CONCLUSIONS

The work is devoted to the study of the interaction of possible tracer gases of explosive substances, in particular NO2, with liquid crystal mixtures of nematic E7 and cholesteric impurity CB15 doped with nanotubes. Previously, the interaction was investigated in three spectral regions, respectively red, green and blue. The two graphs show the interaction of 38 and 44 percent mixtures with NO2 at a concentration of about 100 ppm. We can observe a somewhat faster interaction with the gas for the 44% mixture. Further research will be focused on expanding the range of gases to detect and further investigate the interaction of gases with liquid crystal mixtures doped with nanotubes.

1. *Adegoke, O., & Nic Daeid, N. Colorimetric optical nanosensors for trace explosive detection using metal nanoparticles: advances, pitfalls, and future perspective. Emerging Topics in Life Sciences, 5(3), 2021, p. 367-379.*
2. *Ka Chuen To, Sultan Ben-Jaber and Ivan P. Parkin Recent Developments in the Field of Explosive Trace Detection Cite this: ACS Nano 2020, 14, 9, p.10804–10833.*