

## Preparation And Dielectrical Studies of “Liquid Crystal – Superionic Nanocrystals” Composites

Demko P.Yu.<sup>1</sup>, Bendak A.V.<sup>1</sup>, Studenyak I.P.<sup>1</sup>, Kovalchuk O.V.<sup>2,3</sup>, Lisý V.<sup>4</sup>,  
Kopčanský P.<sup>5</sup>, Timko M.<sup>5</sup>, Tomašovičová N.<sup>5</sup>, Gdovinova V.<sup>5</sup>, Miskuf J.<sup>5</sup>

<sup>1</sup>*Uzhgorod National University, Uzhhorod, Ukraine*

<sup>2</sup>*Kyiv National University of Technologies and Design, Kyiv, Ukraine*

<sup>3</sup>*Institute of Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine*

<sup>4</sup>*Technical University of Košice, Košice, Slovakia*

<sup>5</sup>*Institute of Experimental Physics, Slovakian Academy of Sciences, Košice, Slovakia*

Last few decades the great interest belongs to the studies of the effect of nanoparticles on the properties of various materials, including liquid crystals, in order to obtain compositions with new functional properties. In present investigation Cu<sub>6</sub>PS<sub>5</sub>I superionic nanoparticles is used. Cu<sub>6</sub>PS<sub>5</sub>I compounds belong to the argyrodite family; they are promising materials for creation of solid state batteries, supercapacitors and electrochemical sensors. The ionic conductivity is caused by the presence of Cu<sup>+</sup> ions having high mobility as well as to the peculiarities of the crystal structure which provides high concentration of disordered vacancies and, consequently, migration of copper ions.

The synthesis of Cu<sub>6</sub>PS<sub>5</sub>I compounds was performed as follows: Cu, S, P, and CuI in accordance with the stoichiometry were placed in an evacuated ampoule of quartz glass. The ampoule was heated at a rate 100 K/h to the temperature of 450–500 K and kept at this temperature during 24 h. Then at a rate of 100 K/h the temperature was increased to the maximal value of 1020–1070 K and the ampoule was kept at this temperature during 5-6 days, then they were cooled down to room temperature at a rate 100 K/h. The Cu<sub>6</sub>PS<sub>5</sub>I powders were milled with a planetary ball-mill. For composites preparation Cu<sub>6</sub>PS<sub>5</sub>I superionic nanocrystals with different concentrations were added to liquid crystal 6CB. Dielectric properties of the samples were studied within the frequency range 10<sup>-1</sup>...10<sup>6</sup> Hz at the temperature 293 K by using the oscilloscopic method. The amplitude of the measuring signal with the triangular shape was 0.25 V.

The frequency dependencies of dielectric permittivity of composites were used for calculation of the frequency dependencies of electrical conductivity. The electrical conductivity values were determined on that part of spectra where the electrical conductivity does not depend on frequency. The high values of electrical conductivity in composites in comparison with liquid crystal 6CB are the evidence of their enhancement due to the introduction of Cu<sub>6</sub>PS<sub>5</sub>I superionic nanocrystals into the liquid crystal. It should be noted that the increase of concentration of nanocrystals leads to the increase of composite electrical conductivity.