Nanocomposites and nanomaterials

Electro-conductive properties of ionic metal alkanoate nanocomposites with semiconductor and metal nanoparticles

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The class of thermotropic ionic liquid crystals based on metal alkanoates possesses a number of unique properties, such as intrinsic ionic conductivity, high solvating power and ability to form time-stable mesomorphic glasses at room temperature. These ionic liquid crystals can be used as nanoreactor for the synthesis and stabilization different types of nanoparticles (NPs). The NPs are created into metal alkanoate matrix during the chemical synthesis in the smectic A phase of $(Cd^{+2}(C_7H_{15}COO)^{-2}$, brief - CdC_8 and $(Co^{+2}(C_7H_{15}COO)^{-2}$ brief - CoC8) [1,2]. Three types of NPs were synthesized in these matrices: semiconductor CdS, metal Ag and Au, and metal core-semiconductor shell Au-CdS. These NPs are very stable and well ordered, the size and shape of the NPs are well controlled during the synthesis. Simple template chemical technique to produce the NPs, as well as their unique properties, makes these materials perspective for applications in optical and opto-electronic devices, optical switches, sensors.

We study electro-conductive properties of these nanocomposites with different type of NPs at different temperatures, which correspond to the different phase states of the nanocomposites. We compared the electrical properties of both clean matrix and nanocomposite to clarify the role of NPs and appreciated the quality of new materials. The conductivity of nanocomposites has an activation nature both in anisotropic glassy and smectic A phase. The conductivity of nanocomposites has an activation nature. The conductivity of the nanocomposite along the cation-anion layers is by two orders of magnitude higher than that across the cation-anion layers, which confirms anisotropy of different nanocomposites regardless of the phase of material. Adding nanoparticles in metal alkanoates gives the opportunity to vary the physical properties of materials such as electro-conductivity.

1. *V. Asaula, T. Mirnaya, G. Yaremchuk, S. Volkov. Mehod for producing a liquid crystal glassy nanocomposite materials with semionductro nanoparticles of metal sulfides. – Patent for utility model number 58140, Ukraine, u 201 003 708 IPC (2011.01) C01G11/00, C01G9 /00, C01G21/00, B82B1/00, announced 31.03.2010, published 11.04.2011, Bull. N 7, 2011.*
2. *T. A. Mirnaya, G. G. Yaremchuk, V. M. Asaula, N. A. Leonova, S. V. Volkov. Mehod for producing gold nanoparticles in the liquid crystal caprylate matrix. – Patent for Utility Model Number 86660, Ukraine, u 2013 07 606 IPC (2013.01) C01G7/00, B82B1/00, announced 17.06.2013, published 10.01.2014, Bull. N 1, 2012.*