3rd National Congress on Physical Sciences, 29 Sep. – 2 Oct. 2016, Sofia
Section: Physics of Condensed Matter, New Materials, Cryogenic Physics

Optical and Electro-Optical Properties of Hydrogen Bonded in Dimers Nanostructured Liquid Crystals Mixed with Functionalized Nanoparticles

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Abstract. Hydrogen bonded in dimer liquid crystals (HBDLCs) are a new class of materials, with a large significance for application as tunable electro-optical components in the contemporary photonic devices. They are two structural units of nanocomposites based on HBDLCs, symmetric HBDLCs, where the H-donors and H acceptors are contained in similar and non-symmetric, where the H-donors and H acceptors are contained in unlike molecules. Recently, a wide class of nanocomposites, constituted from non-symmetric structural units, exhibiting both chiral and ferroelectric properties, were created. The HBDLCs, are fundamental components in realization of the contemporary nanostuctural supramolecular liquid crystal materials. Currently, the creating of nanostuctural supramolecular liquid crystal materials and particularly nanocomposites with functionalized for a specific electro-optical effect non-symmetric structural units is one of the topical in the Physics of liquid crystals problem. We investigated a series of nanocomposites produced by mixture of HBDLC, (4,alkyloxybenzoic acid-with homologue number $n = 7$, 7OBA) serving as matrices, with non-mesogenic (functionalized single walled carbon nano-tubes-f,SWCNTs, hydroxypiridine–HOPY, perfluorooctanoic acid-PFOA) and mesogenic (cholesteric benzoate-ChB) nano-particles in various shapes and sizes. Using micro-textural polarization, DSC thermal and X-ray analyses, a set of new chiral ferroelectric phases were found in the nano-composites, otherwise do not appearing in the pristine achiral HBDLCs materials. The conformability, the intra and intermolecular interactions, of the HBDLCs matrix and doped nano-particles were indicated and analyzed by both polarization FT far infrared (FTfIR) and micro-Raman spectroscopies. An unique, previously theoretically predicted, low-temperature ferroelectric smectic phase (S_G), was recognized for the first time in low-molecular liquid crystal systems. The remarkable optical and electro-optical properties of this phase, exposed by fast linear response in the presence of low threshold electric fields, are studied. The electric polarization of the nano-composite HBDLCs/ f, SWCNTs was found to be permanent bulk ferroelectric one, with value ≈ 120 nC/cm^2, thus comparable with that of the solid ferroelectrics, but with important for the tun-

able photonic technique liquidity and large birefringence [1]. A molecular model of the new C_G phase, based on the molecular dimer ring symmetry reduction (bent dimer formation) towards to the lowest triclinic one, produced by the doped nano-particle's actions, is presented. The mechanism of the linear electro-optical responses of the ferroelectric smectric C_G state was discussed.

Acknowledgements. The work is supported by the grant DFNI-T02/18.

References

[1] M. Petrov, B. Katranchev, P.M. Rafailov, H. Naradikian, U. Dettlaff-Weglikowska, E. Keskinova and T. Spassov, 'Phases and properties of nanocomposites of hydrogen-bonded liquid crystals and carbon nanotubes', *Phys. Rev. E* **88** (2013) 042503.