Ultrasonic and Hypersonic Studies of Complex Molecular Dynamics in the Isotropic Phase of a Cholesteric Liquid Crystal

L.M. Sabirov and D.I. Semenov[C,S]
Department of Physics, Samarkand State University, Samarkand, Uzbekistan
denis_sam@mail.ru

The orientational motion of molecules in isotropic liquid crystals is rather complicated, and it is strongly influenced by the type and degree of the local ordering of molecules. Various types of single and collective orientational motions of molecules may be detected at the same time experimentally. To provide a complete study of the orientational relaxation processes in the isotropic phase of liquid crystals, it is necessary to investigate a broad spectrum of relaxation times in a wide temperature interval. For this purpose, acoustic methods are very appropriate.

We studied the behavior of high-frequency sound velocity in the isotropic phase of cholesteric liquid crystal cholesteryl myristate (CM) in a wide frequency range from 2 MHz to 7 HHz, and a temperature range from 373 to 357 K (the phase transition temperature is 356.7 K), in order to obtain information about the relaxation processes and their parameters. Ultrasonic and hypersonic frequency ranges were covered by application of the acousto-optic method and Brillouin light scattering spectroscopy, respectively.

The specific temperature behavior of the sound velocity over the investigated frequency range shows that at least three relaxation processes, which are connected with molecular re-orientations, are manifested in isotropic phase of CM.

The first relaxation process (temperature independent), in the range of 1 to 7 HHz, and the second relaxation process (strongly temperature dependent near the transition temperature), in the range of 2 to 22 MHz, are related to the molecular rotation along the major axis and order parameter fluctuations, respectively. The third hypersonic process is connected to the relaxation of cholesteric order parameter fluctuations (fluctuations of the spiral-like ordering of molecules). Such types of fluctuations may be weakly connected to orientational motions of molecules, but strongly to translational ones within the cholesteric domain. This assumption is confirmed by the absence of a contribution of this type of molecular motion to previously studied spectral distributions of depolarized light scattering in CM.