Liquid crystals (LC) are a fascinating state of matter with a wide application in display application and optoelectronics, especially important in the development of new functional materials, nanolithography, cell engineering, sensors and biosensors, but also providing fundamental models of biological self-organization of matter. It results from the dual nature of LC, resulting from the combination of attributes of solid crystals and isotropic fluids, allowing this "softly" organized and structured structure to be stimulated by external fields, but also having the ability to self-repair the resulting defects. Liquid crystalline materials reacting to external stimuli such as: electric/magnetic fields, light, stresses, pressure, interaction with the surface, chemical agents significantly changing their properties may act as a sensor and device that transmits the obtained effect, but also exhibit feedback features therefore they deserve to be called functional intelligent materials/**meta-materials**. In recent years, the researchers have focused on chiral superstructures and polar order in liquid crystalline (LC) phases of non-chiral V-shape molecules that have bow core or bow dimers with spacers that have odd no of carbons.

The project concerns a group of LC materials that can spontaneously undergo bent deformation of the director leads to emergence of a new nematic order, in which the director follows an oblique helicoid. This **novel phase**, twist-bent (N_{TB} or splay-bent N_{SB}) is a structural link between the well-known uniaxial nematic (N) and chiral nematic (N*) phases. The field-induced distortional effect in N_{TB} may be extremely useful for technological applications as this has similarity to the **electro-clinic effect**. The period of oblique helicoids is is in nanoscale range and therefore the expected electro-optic response time is extremely short of about **1μs** as compare to **ms** range for conventional nematic materials.

The project presents an innovative approach to comprehensive description of macroscopic properties of the material based on their molecular properties. The main goal of the project will be to determine the relationship between the molecular structure and the resulting macroscopic properties of the material. To achieve this, it is necessary to determine the orientation and polar order for a group of liquid crystals (LC) of different molecular structure: different structures of the central part of the mesogen core and the changing structure of chains in tails, and ultimately determine the relationship between the structure of molecules and their ordering and macroscopic properties of liquid crystal phase.

The direct result of the research envisaged in the project will be the determination of a number of macroscopic parameters describing the thermodynamic properties and characterizing the anisotropic physical properties of a group of newly synthesized LC materials with various molecular structure**.** The results of the research will be analyzed within one phenomenological model (Landau theory), as a result of which almost all material properties of the material can be determined due to its use, occurring as parameters in the model. One of the important tasks of the project is to obtain the possibility of modeling the electro-optic effect (EO): ie the effect of electroclinic and switching time and modeling of structural changes as a function of temperature and electric field.

The combination of fast electro-optical (EO) reaction time with analogue properties means that EC liquid crystal materials are extremely attractive for a wide range of applications. Materials we will study are the LC constructed of achiral molecules with a bent core (bent-core BC). This group of materials is particularly interesting to us because of their interplay between polarization and biaxiality. Unlike in the case of calamitic LC, bent cores, even non-chiral ones, may show large spontaneous polarization and biaxiality in orthogonal (SmA-like) and smectic (SmC-like) phases. These materials show fast EO switching, high contrast between ON-OFF states, giving the possibility of their use in fast switching electro-optical devices.

Using polarization microscopy, infrared and Raman spectroscopy, anisotropy measurements of the refractive index and dielectric permittivity anisotropy, the ranges of relevant mesophases and appropriate values of anisotropies measured by these methods will be determined. Planned research includes studying the structure of the molecule system, i.e. local ordering of molecules, macroscopic ordering of phases as well as the dynamics of molecular and collective processes. The extent of local order correlation determined from the widening of the peaks in the X scattering image will be compared with the range of correlation polar order determined from dielectric measurements and polarization. An approximate ODF distribution function and corresponding order parameters will be determined using birefringence measurements.