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Wpływ ciśnienia na polimorfizm i dynamikę w 4-butylobenzoesanie 4-cyjano-3-fluorofenylu

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High pressure influence on dynamics and polymorphism of 4-cyano-3-fluorophenyl 4-butylbenzoate

The investigations of liquid crystals are still one of interesting issues, which bring an increasing number of publications. Many of these substances show tendency to reach easily glassy state of isotropic phase or of partially ordered phases. Understanding and description of phenomenon of glass transition seem one of the most important problems in condensed matter physics.

Studies of dynamics and polymorphism presented in this thesis were performed for 4-cyano-3-fluorophenyl 4-butylbenzoate (4CFPB). Molecule of the 4CFPB is characterized by a cyano group and a lateral fluorine atom. Fluorinated substances often show interesting properties, so 4CFPB is a great material for extensive research. Additionally, presented substance occurs a glassformer and shows nematic glass with long range orientational order of molecules.

This thesis is concentrated around dynamics and phase transitions of 4CFPB liquid crystal in various pressure conditions. Polymorphism investigations at normal pressure were performed by adiabatic calorimetry, differential scanning calorimetry and polarizing microscopy observations. Investigated substance shows reach polymorphism with three solid and two liquid phases. During cooling isotropic phase, nematic and glass of the nematic were observed. Heating the sample allowed to identify softening of glass, to propose its new signature and to reveal two crystalline phases. Additionally, at high pressure in isothermal experiment liquid-like smectic A phase was detected. Thanks to measurements of 4CFPB at various pressures, in case of nanopores lower than normal pressure, phase diagram was constructed.

Pressure experiments based on broadband dielectric spectroscopy were carried out at normal pressure, high pressure in isobaric and isothermal conditions and in nanopores. At normal pressure three molecular motions were detected and described. Main of structural processes is connected with motions around short axes and the second with procession of molecules. Secondary process, occurring mostly in glass was positively tested as Johari-Goldstein type and ascribed to librations of molecules. These processes were observed at normal and high pressure. In nanopores additionally absorption peaks connected with raptation motions were found. Heated substance placed in 8 nm nanopores shows collective motions.

Summarizing, 4CFPB glass forming liquid crystal was treated by various pressure conditions. The influence of pressure (higher and lower than normal) on the phase diagram as well as on molecular dynamics was examined. The ranges of pressure and temperature existence of 4CFPB phases were defined. Description of pressure influence on characteristics of complex molecular dynamics was accomplished.