Vibrational and electronic spectra of low-dimensional organic conductors and superconductors

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Introduction

Crystalline organic conductors are very attractive materials from the point of view of basic research because of richness of electronic and magnetic states, and also because of potential possibilities of application in molecular electronics and spintronics. In the Department of Molecular Crystals, using various infrared (IR) and Raman spectroscopic techniques, we study these materials in a broad temperature range, mostly salts formed by TTF (tetrathiofulvelene) derivatives with various electron acceptors. The most interesting are molecular systems, in which a modification of charge distribution on molecules (charge ordering) and related with this effect the so-called electronic ferroelectricity are observed on temperature decreasing, and systems which exhibit combination of various properties, e.g. conducting and magnetic. In IR spectra of the organic conductors we observe electronic bands related to charge-transfer transitions and vibrational features being a consequence of coupling between electrons and intramolecular vibrations. The analysis of electronic bands in IR spectra allows to determine the crystal electronic structure and Coulomb interactions between charge carriers. On the other hand, on basis of vibrational features (IR and Raman) it is possible to describe the charge distribution on molecules and its modifications due to the charge ordering transitions. It is planned that a PhD student will be included into a program of cooperation with the University of Rennes (France) and the University of Stuttgart (Germany).

Research project objectives and methodology

The research will be focused on studies of the electronic structure, charge distribution on molecules, electron – intramolecular vibration coupling, and phase transitions in new organic conductors and superconductors, including also multifunctional systems. Basic task of the PhD student will be measurements of polarized IR reflectance spectra as a function of temperature (T = 5 - 300 K) using a FT-IR spectrometer Bruker Equinox 55 (FIR, MIR, NIR) equipped with a FT-IR microscope Hyperion 1000. The IR studies will be supplemented by measurements of Raman scattering spectra (also as a function of temperature) by using a spectrometer Labram HR HORIBA Jobin Yvon equipped with three lasers: He-Ne laser (633 nm), argon-ion laser Stabilite 2017 (several excitations un the range 454-514 nm) and NIR laser (780 nm). If necessary, the absorbance spectra in visible and ultraviolet regions as well as fluorescence spectra will be also measured. Some spectral studies in FIR region and measurements under hydrostatic pressure and/or magnetic field will be performed in Stuttgart.