UZHHOROD NATIONAL UNIVERSITY

XIII International seminar

“Properties of ferroelectric and superionic systems”

Uzhhorod, October 29, 2024

Programme and abstracts

http://seminar.pp.ua

Uzhhorod 2024

XIII International seminar "Properties of ferroelectric and superionic systems"

Uzhhorod, October 29, 2024

ORAL SESSION

OPENING 9.50

Chairman Yu. Vysochanskii

1 **Ag(Tl)–Sb(In)–P–Se SYSTEMS: phase formation, crystal chemistry, technology and properties.** 10.00 - 10.30
I. Barchiy[1], V. Sabov[1], M. Sabov[1], A. Pogodin[1], M. Piasecki[2], V. Pavlyuk[2,3], O. Khyzhun[4], A. Fedorchuk[5]
[1] *Uzhhorod National University, Ukraine*
[2] *J.Dlugosz University, Częstochowa, Poland*
[3] *I.Franko Lviv National University, Ukraine*
[4] *Institute for Problems in Materials Sciences NAS of Ukraine, Kyiv, Ukraine*
[5] *Lviv National University of Veterinary Medicine and Biotechnologies, Ukraine*

2 **Size-Induced, Strain-Induced and Ionic-Induced Effects in Low-Dimensional Ferroelectric Materials** 10.30- 11.00
A. N. Morozovska[1], E. A. Eliseev[2], Yu. M. Vysochanskii[3], and S. V. Kalinin[4]
[1] *Institute of Physics, NASU, Kyiv, Ukraine*
[2] *Frantsevich Institute for Problems in Materials Science, NASU, Kyiv, Ukraine*
[3] *Institute of Solid-State Physics and Chemistry, Uzhhorod University, Ukraine*
[4] *Department of Materials Science and Engineering, University of Tennessee, USA*

3 **Dielectric, elastic, and thermal characteristics of NH_4HSO_4 ferroelectric within the framework of a two-sublattice pseudospin model** 11.00- 11.30
A.S.Vdovych[1], I.R.Zachek[2], O.B.Bilenka[2]
[1] *Institute for Condensed Matter Physics of the NASU, Lviv, Ukraine*
[2] *Lviv Polytechnic National University, Ukraine*

4 **Ground state study of local potential transformation in the $Sn_2P_2S_6$-type ferroelectrics** 11.30- 12.00
O.V. Velychko
Institute for Condensed Matter Physics of the NAS of Ukraine, Lviv, Ukraine

5 **Ferro-Ionic Coupling Impact on Polarization Switching and Electrophysical Properties in $Bi_{1-x}Sm_xFeO_3$ Nanoparticles** 12.00- 12.30
A. N. Morozovska[1], E. A. Eliseev[2], O. S. Pylypchuk[1], I. V. Fesych[3], and S. V. Kalinin[4]
[1] *Institute of Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine*
[2] *Frantsevich Institute for Problems in Materials Science, NAS of Ukraine, Kyiv, Ukraine*
[3] *Taras Shevchenko National University of Kyiv, Ukraine*
[4] *Department of Materials Science and Engineering, University of Tennessee, USA*

POSTER SESSION (online) 12.30- 13.30

BREAK

Chairman A. Grabar

6 **Investigation of macroscopic polarization switching in layered $CuInP_2S_6$ crystals** 14.00- 14.30
D. Gál [1,2], H. Bán [3], V. Minkovich [3], V. Gerasimov[4], A. Horvat[3], A. Molnar[3]
1 HUN-REN Wigner Research Centre for Physics, Budapest, Hungary
2 University of Pécs, Pécs, Hungary
3 Uzhhorod National University, Ukraine
4 Mukachevo State University, Ukraine

7 **Enhancement of the efficiency of acousto-optic diffraction in electric and magnetic fields** 14.30- 15.00
O. Mys, D. Adamenko, R. Vlokh
O.G. Vlokh Institute of Physical Optics of the Ivan Franko National University of Lviv, Ukraine

8 **Co-doped $Sn_2P_2S_6$ crystals: photorefractive parameters and possible applications** 15.00- 15.30
V. Voloshyn, M. Tsyhyka, K. Glukhov, R. Pavlyshyn, A. Grabar
Uzhhorod National University, Ukraine

9 **Raman scattering study of $CuInP_2S_6$ type 2D ferrielectrics near the monoclinic-trigonal boundary**. 15.30- 16.00
Yu. Vysochanskii, V. Liubachko, R. Yevych, K. Glukhov, V. Hryts,, M. Medulych, A. Pogodin, A. Kohutych
Uzhhorod National University, Ukraine

CLOSING 16.00

POSTERS

1. **On the 'bond length versus bond valence/order' correlation curve for hydrogen–oxygen bonds in solids**
V. Sidey
Uzhhorod National University, Ukraine

2. **Refractive and dilatometric parameters of rubidium sulfate crystals**
I.A. Pryshko[1], V.Yo Stadnyk[1], P.A. Shchepanskyi[1], I.M. Matviyishyn[2], V.Ya. Baliga[1]
[1] Physics Faculty, Ivan Franko National University of Lviv, Ukraine
[2] Faculty of Electronics and Computer Technologies, Ivan Franko National University of Lviv, Ukraine

3. **Investigation of microhardness of single crystal of $Ag_{7+x}(P_{1-x}Ge_x)S_6$ solid solutions**
I. Shender[1], A. Pogodin[1], M. Filep[1,2], T. Malakhovska[1], O. Kokhan[1], L. Suslikov[1], V. Bilanych[1]
[1] Uzhhorod National University, Ukraine
[2] Ferenc Rákóczi II Transcarpathian Hungarian Institute, Beregovo, Ukraine

4. **Exciton Luminescence of $CsSnBr_3$ crystals**
V. Shvets, A.Pushak, O. Antonyak, T.Demkiv, A. Voloshinovskii
Ivan Franko National University of Lviv, Ukraine

5. **Acoustic properties of $Cu(Ag)_7SiS_5I$ crystals in the temperature range 300÷380 K**
Mykyta O.I., Fedelesh V.I., Shender I.A., Pogodin, A.I.
Uzhhorod National University, Ukraine

6. **EPR spectra of Mn ions in the paraelectric phase of $LiNaGe_4O_9$: crystal**
M.P. Trubitsyn[1,2], V. Laguta[1,3], A.O. Diachenko[2], M.D. Volnianskii[2]
[1] Institute of Physics of the Czech Academy of Sciences, Prague, Czech Republic
[2] Oles Honchar Dnipro National University, Ukraine
[3] Frantsevich Institute for Problems of Materials Science NAS Ukraine

7. **Temperature-spectral properties β-$LiNH_4SO_4$ crystals with an admixture of Mn^{2+} and Cu^{2+}**
R. S. Brezvin, A. O. Shapravskyi, P. A. Shchepanskyi, M. Ya. Rudysh, V. Yo. Stadnyk,
A. V. Larchenko, T. M. Pasitskyy, V. Ya. Baliha
Physics Faculty, Ivan Franko National University of Lviv, Lviv 79005, Ukraine

8. **Influence of X-ray irradiation on the thermochromic effect in polymer microcomposites based on $[NH_2(C_2H_5)_2]_2CuCl_4$ crystals**
V. Davydovych, V. Kolomiiets, Yu. Chornii, V. Kapustyanyk,
Faculty of Physics, Ivan Franko National University of Lviv, Ukraine

9. **Characteristics of a pulsed-periodic gas-discharge source of ultraviolet radiation fluxes and microstructures of silver sulfide**
R. Hrytsak, O. Shuaibov, O. Minya, Z. Homoki, R. Holomb, A. Pogodin
Uzhhorod National University, Ukraine

10. **Structural and electronic properties of Ag_3AsS_3: A first-principles density-functional theory study within DFT-D and DFT-D+U methods**
T. Babuka[1], I. Babuka[1], O.O. Gomonnai[1], A.V. Gomonnai[2]
[1]Institute of Physics and Chemistry of Solid State, Uzhhorod National University, Ukraine
[2] Institute of Electron Physics, Nat. Acad. of Sci. of Ukraine, Uzhhorod, Ukraine

11. **Demultiplexing of optical beam with using of Raman-Nath acousto-optic diffraction and singular acoustic beam**
I. Skab, M. Kostyrko, O. Krupych, R Vlokh
O.G. Vlokh Institute of Physical Optics of the Ivan Franko National University of Lviv, Ukraine,

12. **Modeling of van der Waals heterostructures based on β-InSe and $MoSe_2$ crystals: electronic and optical properties**
O. I. Korolov, L. Yu. Kharkhalis, K. E. Glukhov
Institute for Physics and Chemistry of Solid State, Uzhhorod National University, Ukraine

13. **Classical models of long-term mechanical relaxation in As-Se glasses**
V. Minkovich, M. Povhanich, Y. Tsisaruk, A. Horvat
Department of Semiconductor Physics, Uzhhorod National University, Ukraine

14. **Dielectric properties of polycrystalline and single-crystalline $TlInS_2$ in the vicinity of phase transitions**
P. Huranych[1], A. G. Slivka[1], P. P. Guranich[1], R. R. Rosul[1], O. O. Gomonnai[1], A. V. Gomonnai[2], V. M. Rubish[3]
[1] Uzhhorod National University, Uzhhorod, Ukraine
[2] Institute of Electron Physics, NAS of Ukraine, Uzhhorod, Ukraine
[3] Uzhhorod Laboratory of Optoelectronics and Photonics Materials. Institute for Information Recording, NAS of Ukraine

15. **Features of the relaxation behavior of the dielectric properties of $CuInP_2S_6$ layered crystals at high hydrostatic pressures.**
V. S. Shusta[1], A. G. Slivka[1], V. A. Kalytyn[1], V. Y. Biganich[1], A. I. Susla[1], V. Y. Shusta[2]
[1] The Department of Physics, Uzhhorod National University, Ukraine
[2] SE"IVANO-FRANKIVSKSTANDARTMETROLOGY" Ivano-Frankivsk, Ukraine

16. **Phonon spectra and states densities of cubic system crystals in the concept of superspace symmetry**
A. Korneychuk, M. Pino, E. Yakyma, V. Senko, I. Nebola
Uzhhorod National University, Faculty of Physics, Uzhhorod, Ukraine

17. **Electronic structure and optical properties of zinc-containing halide perovskites**
M. Ya. Rudysh, A.V. Larchenko, A. O. Shapravskyi, P. A. Shchepanskyi, T.M. Pasitskyy, A. S. Voloshinovskii
Physics Faculty, Ivan Franko National University of Lviv, Lviv 79005, Ukraine

Investigation of macroscopic polarization switching in layered $CuInP_2S_6$ crystals

D. Gál[1,2], H. Bán[3], V. Minkovich[3], V. Gerasimov[4], A.Horvat[3], A. Molnar[3]

[1] *HUN-REN Wigner Research Centre for Physics, Budapest, 1121 Hungary*
[2] *University of Pécs, Pécs, 7624 Hungary*
[3] *Uzhhorod National University, Uzhhorod, 88000 Ukraine*
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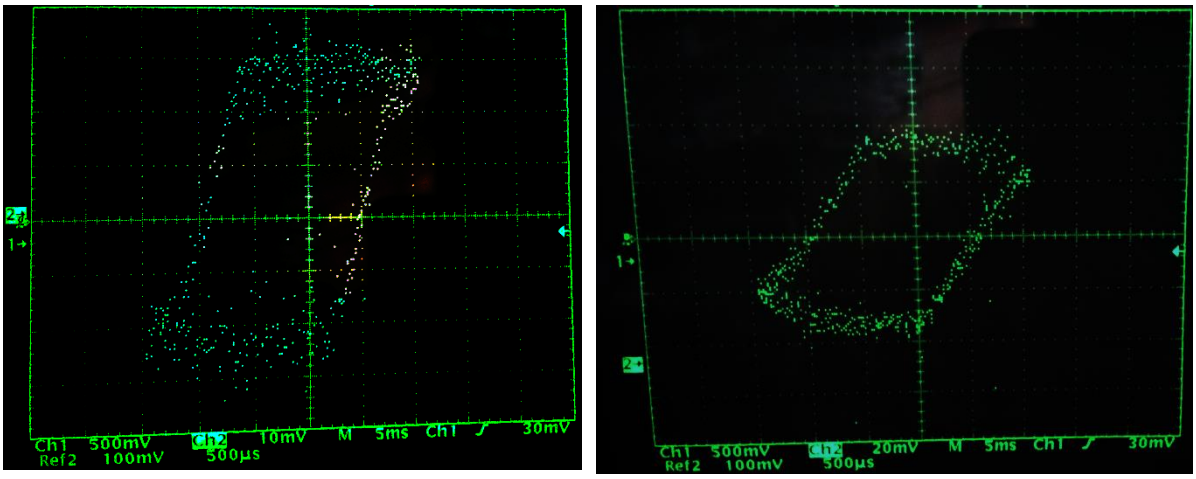
With the rapid beginning of graphene research, interest in layered van der Waals materials has grown significantly. Among them, the Phosphorous Trichalcogenides group, which possess unique physical properties, stands out. In the list of these crystals, we can meet ferroelectrics, antiferroelectrics, ferromagnetics, ionic conductors, semiconductors, dielectrics, and others. Of particular interest are $CuInP_2S_6$ crystals, which below the Curie temperature $T < T_C = 315K$ are ferrielectrics with spontaneous polarization $P_S = 3\ \mu C/cm^2$ directed perpendicularly to the structural layers. The coercivity field of these crystals is 77 kV/cm. Moreover, unlike most ferroelectrics, the ferrielectric properties of $CuInP_2S_6$ crystals are preserved even at thicknesses of units of nanometers (for example, $Sn_2P_2S_6$ crystals cease to exhibit ferroelectric properties at a size of less than 50 microns), which makes it very promising for use in modern electronics. It has already been used to create major electronic components such as diodes, transistors, ferroelectric transistors with negative capacitance, memory cells, and others. The last two applications are closely related to the phenomenon of switching spontaneous polarization under the action of an external electric field, so studying this phenomenon is an urgent task. In the available works, switching phenomena were mainly studied on a microscopic scale, using force microscopy technology. The data on macroscopic parameters of $CuInP_2S_6$ crystals (spontaneous polarization, its temperature behavior, the presence of shifting electric fields, and the magnitude of the coercive field) are very few, so we carried out studies of the switching processes of spontaneous polarization on samples of relatively large size.



300K **305K**

Fig. 1. Temperature evolution of dielectric hysteresis loops of $CuInP_2S_6$ crystal.

A $CuInP_2S_6$ crystal obtained from the gas phase, 20 μm thick, 5x5 mm^2 with gold electrodes sputtered in a vacuum with an area of 2x2 mm^2, was chosen for our studies. The remaining part of the crystal surface served as an additional protection against surface breakdown. Based on the crystal thickness and the coercive field value of $7.7 \cdot 10^6$ V/m · $2 \cdot 10^{-5}$ m = 154 V, we used a high-voltage amplifier with an output voltage of ±160 V (Operational Amplifier Burr-Brown 3584). To investigate the switching processes, we used a standard Sawyer−Tower scheme. The frequency of the measurement field was 100 Hz (copper ions did not have time to migrate through the sample thickness). The waveform was triangular and bipolar. The crystal was first annealed at 400K for three hours without applying an electric field to clean the sample from moisture and intercalating impurities before measurements. $CuInP_2S_6$ was then cooled to room temperature, and further dielectric hysteresis loop measurements were performed in the heating regime from 290K to 370 K. The resulting dielectric hysteresis loops are shown in Figure 1.