



Аннотации на английском языке

Original articles

Research article

<https://doi.org/10.17308/kcmf.2026.28/13554>**Tunable magnetic, dielectric, and optical properties of cobalt ferrite/PVA nanocomposites: Effect of nanoparticle calcination temperature**Noor A. Saeed¹, Wafaa A. Hussain¹, Mukhlis M. Ismail¹, Mudatheer M. Al-Slivani²¹Department of Applied Physics, College of Applied Science, University of Technology, Baghdad, Iraq²Al-Furqan University, College of Education for Pure Sciences, Department of Physics, Mosul, Iraq**Abstract****Objectives:** This study investigates the magnetic and dielectric properties of nanocomposites composed of cobalt ferrite (CoFe₂O₄) nanoparticles embedded in a polyvinyl alcohol (PVA) matrix.**Experimental:** CoFe₂O₄ nanoparticles were synthesized via a sol-gel auto-combustion method and subsequently calcined at 600 and 900 °C. X-ray diffraction results indicated that increasing the calcination temperature from 600 to 900 °C led to an increase in crystallite size from 23.3 nm to 48.5 nm. This was accompanied by an enhancement in saturation magnetization (*M_s*) from 68.7 emu/g to 81.3 emu/g and a decrease in coercivity (*H_c*) from 1150 to 860 Oe.**Conclusions:** Most importantly, the PVA/CoFe₂O₄ composites exhibited enhanced dielectric properties compared to pure PVA. At 100 Hz, the dielectric constant (ϵ') of the composite increased from approximately 18 (for PVA/CF600) to 42 (for PVA/CF900), values significantly higher than that of pure PVA, which was approximately 9. This enhancement highlights a synergistic effect between the ferrite nanoparticles and the polymer matrix, opening possibilities for designing composites with tunable dielectric responses for applications such as embedded capacitors and electromagnetics wave absorption devices.**Keyword:** Cobalt ferrite, Nanocomposites, Polyvinyl alcohol (PVA), Magnetic properties, Dielectric constant, Optical band gap, Sol-gel**For citation:** Saeed N. A., Hussain W. A., Ismail M. M., Al-Slivani M. M. Tunable magnetic, dielectric, and optical properties of cobalt ferrite/PVA nanocomposites: Effect of nanoparticle calcination temperature. *Condensed Matter and Interphases*. 2026;28(1): 3–14. <https://doi.org/10.17308/kcmf.2026.28/13554>

Research article

<https://doi.org/10.17308/kcmf.2026.28/13555>**On the formation of the Ag₂Si metastable phase in an Ag-Si film obtained by ion-beam sputtering**K. A. Barkov¹, V. V. Babakov¹, G. P. Potudansky¹, S. A. Ivkov¹, Ya. A. Peshkov¹, I. V. Polshin¹, E. S. Kernovsky¹, S. Y. Khydyrova², K. M. Moiseev², I. E. Zanin¹, A. K. Pelagina¹, N. S. Buylov¹, Tran Van Tu³, A. E. Nikonov⁴, A. V. Sitnikov⁴¹Voronezh State University,

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Abstract**Objectives:** Nanocomposite films based on Ag-Si compounds have application in many areas of science and technology. However, their manufacturing process can be accompanied by the formation of silicides and metastable phases. In this connection, the task of developing methods for their identification arises. In this work, we attempted to solve this task using X-ray diffraction, ultra-soft X-ray emission spectroscopy, and theoretical calculations of the electron density of states for an Ag₅₅Si₄₅ film obtained by ion-beam sputtering of a composite target.**Experimental:** As a result of comprehensive studies, a nanogranular structure of the film was revealed, with an average silver particle size of ~15 nm, separated by a matrix based on phases of amorphous silicon *a*-Si, SiO₂, and suboxide SiO_{1.3}, as well as a silver silicide phase. A comparison of the experimental Si *L*_{2,3} X-ray emission spectrum of the Ag₅₅Si₄₅ film with theoretically calculated spectra of the AgSi₃, Ag₂Si, and Ag₃Si phases shows the best agreement with the spectrum of the Ag₂Si phase. Moreover, the Ag₂Si phase was detected in the works of other authors.**Conclusions:** Thus, based on X-ray diffraction, X-ray emission spectroscopy, and theoretical calculations of the electronic density of states, it has been established that a metastable Ag₂Si phase is formed in the Ag₅₅Si₄₅ film produced by ion-beam sputtering.**Keywords:** Metastable Ag-Si-based phases, AgSi₃, Ag₂Si, Ag₃Si, silver silicides, ion-beam sputtering, Ultra-soft X-ray emission spectroscopy (USXES), Electronic density of states (DOS)**Funding:** This work was funded by the Russian Science Foundation, under grant number 23-79-10294, <https://rscf.ru/project/23-79-10294/>

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Research article

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Electrochemical reduction of nitrate ions on copper coatings of various roughness under conditions of mixed transport and kinetic control

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Abstract

Objectives: In this work, the influence of electrode surface roughness on the kinetics of the non-stationary electrochemical process of cathodic reduction of nitrate ion under conditions of mixed transport-kinetic control under potentiostatic polarization conditions is established.

Experimental: The research was carried out on two copper coatings obtained by galvanostatic deposition from a copper sulfate electrolyte, which was supplemented with various organic additives to vary the roughness of the synthesized copper coatings. The kinetics of the electrochemical reduction of nitrate ions on the obtained copper coatings were studied by transient electrochemical methods of voltammetry and chronoamperometry in an aqueous deaerated solution of 10 mM KNO₃ + 100 mM H₂SO₄. Potentiostatic measurements were performed at a cathodic potential of -470 mV, corresponding to a mixed transport-kinetic control. The surface roughness of the synthesized copper coatings was evaluated using atomic force microscopy and underpotential deposition of lead monolayer.

Conclusion: Based on the previously developed theoretical model of the electrochemical process occurring in a mixed transport-kinetic mode on a rough electrode, an approach is proposed for estimating the main parameters of the kinetic stage, taking into account normalization to the real surface area, using the example of the electrochemical reduction of nitrate ions on copper coatings of various roughness. Within the framework of this approach, it was found that a rougher copper coating is characterized by higher values of the heterogeneous constant of the rate and density of the exchange current, which indicates an increase in the electrocatalytic activity of copper in the reaction under study during the transition to electrodes with increased roughness.

Keywords: Surface roughness, Copper coating, Nitrate ion, Electrochemical reduction, Mixed kinetics, Atomic force microscopy, Voltammetry, Chronoamperometry

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Acknowledgements: The AFM studies were performed on the equipment of the Center for the Collective Use of Scientific Equipment of Voronezh State University.

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Research article

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Silicon nanowires modified with Au/Ag nanoparticles for the label-free detection of prostate-specific antigen using surface-enhanced Raman spectroscopy

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Abstract

Objective: Prostate-specific antigen (PSA) is an important biomarker widely used for the early diagnosis of prostate cancer. In this work, substrates based on silicon nanowires coated with bimetallic gold and silver nanoparticles (AuAg@SiNWs) are presented for the highly sensitive detection of PSA using surface-enhanced Raman spectroscopy (SERS).

Experimental: The fabrication of AuAg@SiNWs was based on simple and readily accessible chemical etching and metal deposition techniques, making the approach suitable for scaling and potential biomedical applications. The thickness of the silicon nanowire array was approximately 800 nm, while the bimetallic nanoparticle layer was formed predominantly in the upper region of the nanostructures and exhibited a thickness of 100–200 nm. To ensure the biospecificity of the sensor, the surfaces of the AuAg@SiNW substrates were functionalized with antibodies.

Analysis of the SERS spectra revealed a clear dependence of the intensity of characteristic amide bands (in particular, at 1294 and 1030 cm⁻¹) on the PSA concentration, starting from 1 ng/mL. The calculated calibration curve in the concentration range of 0.001–1 µg/mL demonstrated a high degree of linearity ($R^2 = 0.96$), while the stable presence of characteristic spectral features at a concentration of 1 ng/mL indicates the high functional sensitivity of the proposed platform.

Conclusions: The results obtained demonstrate that AuAg@SiNW-based substrates possess significant potential for label-free and highly sensitive detection of protein cancer biomarkers, including PSA, and can be used as a platform for the development of compact biosensors for laboratory diagnostics and point-of-care applications.

Keywords: Silicon nanowires, Prostate-specific antigen (PSA), Surface-enhanced Raman spectroscopy

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Research article

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Thermodynamic study of the BiSI-BiSeI system by the electromotive force method

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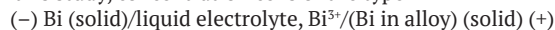
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Abstract

Objectives: Chalcogenides of arsenic subgroup elements and solid solutions based on them are of great interest as functional materials exhibiting thermoelectric, photoelectric, piezoelectric, optical, and other properties.

Experimental: This paper presents the results of a study of the thermodynamic properties of BiSI, BiSeI, and BiS_{1-x}Se_xI solid solutions using electromotive force (EMF) analysis. For this study, concentration cells of the type



were constructed and their EMFs were measured in the temperature range of 300–370 K. An ionic liquid, namely, morpholine formate, was used as the electrolyte. To select the compositions of the right-hand electrodes, solid-state equilibria in the BiSI-BiSeI-BiI₃ system were studied using X-ray diffraction analysis. Continuous solid solutions of the BiSI-BiSeI boundary system were shown to form stable tie-line with BiI₃. Using these data and literature information on boundary systems, a fragment of the solid-phase equilibria diagram for the Bi-S-Se-I system was constructed. Based on constructed diagram, the BiS_{1-x}Se_xI solid solutions of various compositions with a 2–3 mol % excess of BiI₃ and S_{1-x}Se_x were selected as electrode-alloys for the aforementioned concentration cells. The partial molar functions of bismuth in the alloys were calculated from the obtained pairs of $E(\text{mV})$ and $T(\text{K})$ values.

Conclusions: The constructed phase diagram made it possible to determine the virtual reactions of potential formation corresponding to the aforementioned partial molar functions and calculate the standard thermodynamic functions of formation and the standard entropies of bismuth thio- and selenoide and BiS_{1-x}Se_xI solid solutions. The calculations were performed using literature data on the corresponding standard integral thermodynamic functions of the BiI₃ compound and S_{1-x}Se_x alloys involved in potential-forming reactions. The thermodynamic functions of the BiSI and BiSeI compounds were compared with existing fragmentary literature data, and for solid solutions, they were determined for the first time.

Keywords: Bismuth chalcogenides, Phase diagram, Solid solutions, EMF method, Thermodynamic functions, Ionic liquid

For citation: Qurbanov A. A., Ahmadov E. J., Shukurova G. M., Alverdiyev I. J., Jafarov Y. I. Thermodynamic study of the BiSI-BiSeI system by the electromotive force method. *Condensed Matter and Interphases*. 2026; 28(1): 46–56. <https://doi.org/10.17308/kcmf.2026.28/13590>

Research article

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Kinetics of cathodic deposition of copper from an acid sulfate solution in the presence of organic disulfides

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Abstract

Objectives: In this work, we established the kinetic patterns and evaluated the main parameters of heterogeneous nucleation and growth of a new phase during the electrocrystallization of copper during cathode deposition from an acid sulfate solution in the presence of organic disulfides (disodium salts of 3,3'-dithiodipropanedisulfonic acid, 4,4'-dithiodibenzene disulfonic acid and 3,3'-dithiodi(4-aminobenzene) sulfonic acids). The additives under study contain a disulfide group (-S-S-), which is characteristic of accelerators of the copper cathode deposition process in the implementation of electrochemical void-free filling of through holes (through silicon vias) of silicon wafers used in microelectronics in the manufacture of microcircuits.

Experimental: Electrodeposition of copper coatings was carried out from aqueous sulfate solutions of copper plating in galvanostatic mode. Using scanning electron microscopy, it was found that in the presence of all the studied organic disulfides, copper crystallites with clearer edges are formed in the acid sulfate electrolyte of copper plating than in solutions without additives. The presence of aromatic groups in the structure of the accelerator molecule increases the size of the crystallites of the galvanic copper deposit, and the additional introduction of terminal amino groups into the disulfide structure, on the contrary, leads to a decrease in the size of the crystallites. The latter can be explained by the bifunctional nature of 3,3'-dithiodi(4-aminobenzene)sulfonic acid, capable of exhibiting both an accelerating and leveling effect due to the presence of a disulfide group and an amino group in the structure, respectively. The kinetics of cathodic deposition of copper coatings was studied using transient electrochemical methods of voltammetry, chronopotentiometry, and chronoammetry. In the presence of the studied additives, the overvoltage of copper electrodeposition decreases, while the kinetics of the process does not change: the charge transfer stage proceeds irreversibly, the activation of nucleation sites is progressive, and the growth of a new phase is controlled by the diffusion of copper ions from the solution to the cathode surface.

Conclusions: The functionalization of aliphatic disulfide by the introduction of aromatic and amino groups does not lead to significant changes in the parameters of heterogeneous nucleation and the growth of a new phase during cathodic deposition of copper from an acid sulfate solution. However, the rate of electrocrystallization increases with the transition from aliphatic disulfide (disodium salt of

3,3'-dithiodipropanedisulfonic acid) to disodium salt of 3,3'-dithiodi(4-aminobenzene)sulfonic acid, which contains both aromatic groups and amino groups in its structure.

Keywords: Copper, Cathodic deposition, Organic disulfides, Kinetics, Voltammetry, Chronopotentiometry, Phase formation

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Acknowledgements: The SEM studies were performed on the equipment of the Center for the Collective Use of Scientific Equipment of Voronezh State University.

For citation: Ilina E. A., Kozaderov O. A., Sotskaya N. V., Golovinsky A. D., Kolbeshkina E. D., Polikarchuk V. A. Kinetics of cathodic deposition of copper from an acid sulfate solution in the presence of organic disulfides. *Condensed Matter and Interphases*. 2026;28(1): 57–68. <https://doi.org/10.17308/kcmf.2026.28/13559>

Research article

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Microstructural and hydrophilic properties of acrylonitrile-butadiene-styrene copolymer ABS samples with different 3D-printed patterns

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Abstract

Objectives: The aim of this study is to investigate the influence of different 3D printing patterns, under identical thermal and mechanical parameters of the 3D printing process itself, on the microstructural and hydrophilic properties of amorphous ABS copolymer samples printed with five different 3D printing patterns by sequentially depositing layers using FDM (Fused Deposition Modeling).

Conclusions: The results of studying the printed samples using SEM, X-ray diffraction, IR spectroscopy, and contact angle measurements showed that the combination of thermal and mechanical effects during 3D printing in the studied extrusion mode does not cause noticeable orientation of the polymer chains of the original amorphous ABS copolymer, does not disrupt its intrastuctural chemical bonds, and the surface of all printed samples with five different patterns is hydrophilic. Moreover, the printed sample with the most complex geometry is the 1_Hilbert pattern, which has the most distorted morphology and surface defects and exhibits the highest contact angle ($\varphi = 67^\circ$), exceeding the corresponding values in samples with other patterns ($\varphi \approx 60^\circ$) by $\sim 10\%$, and has a hydrophilic surface.

Keywords: Acrylonitrile-butadiene-styrene copolymer ABS, Various 3D-printed patterns, Printed samples, Surface morphology, Amorphous state, IR spectra, Contact angles, Hydrophilic surface.

Funding: This work was supported in part by the Ministry of Education and Science of the Russian Federation under a state assignment for universities in the field of scientific activity, project no. FZGU-2026-0009, and the Advanced Engineering School of VSU.

For citation: Lenshin A. S., Frolova V. E., Makagonov V. A., Pelagina A. K., Domashevskaya E. P. Microstructural and hydrophilic properties of acrylonitrile-butadiene-styrene copolymer ABS samples with different 3D-printed pattern designs. *Condensed Matter and Interphases*. 2026;28(1): 69–80. <https://doi.org/10.17308/kcmf.2026.28/13588>

Research article

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Effect of Sr²⁺ ions on the gas-sensitive properties of LaCrO₃ and GdCrO₃

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Abstract

Objectives: Thin films obtained from La_{1-x}Sr_xCrO_{3-δ} and Gd_{1-x}Sr_xCrO_{3-δ} ($x = 0.05, 0.10, \text{ and } 0.15$) synthesized by the modified citrate method were studied.

Experimental: An analysis of the phase composition, structure, and gas-sensitive properties of films in the presence of carbon monoxide was carried out. Doping with Sr²⁺ ions led to an increase in the defect rate of nanoparticles due to the formation of vacancies in the oxygen sublattice. This phenomenon had a positive effect on their gas-sensitive properties.

Conclusions: It was found that samples of La_{0.9}Sr_{0.1}CrO_{3-δ} and Gd_{0.9}Sr_{0.1}CrO_{3-δ} showed the highest sensory response at 180°C, 2.26 and 1.78, respectively. The results obtained confirmed the prospects of using these materials as gas sensors.

Keywords: Nanopowders, Perovskites, Gas-sensitive properties, Pechini method, LaCrO₃, GdCrO₃, Sr²⁺ doping

Acknowledgements: The research results were partially obtained on the equipment of the Voronezh State University Center for Collective Use: <http://ckp.vsu.ru>

For citation: Nemykh Y. M., Kostryukov V. F., Gorbunov I. N., Tomina E. V. Effect of Sr²⁺ ions on the gas-sensitive properties of LaCrO₃ and GdCrO₃. *Condensed Matter and Interphases*. 2026;28(1): 81–91. <https://doi.org/10.17308/kcmf.2026.28/13591>

Research article

<https://doi.org/10.17308/kcmf.2026.28/13561>**Semi-empirical description of the regularity of change in thermal conductivity of single crystals based on the example of a concentration series of Ba_{1-x}La_xF_{2+2x} solid solutions**P. A. Popov¹, A. V. Shchelokov¹, N. V. Mitroshenkov¹, A. A. Kushnereva¹, V. A. Konyushkin², A. N. Nakladov¹, P. P. Fedorov², S. V. Kuznetsov²¹Petrovsky Bryansk State University

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Abstract**Purpose:** To study the thermal conductivity of single crystals of a Ba_{1-x}La_xF_{2+2x} solid solution and a semi-empirical description of changes in thermal conductivity depending on the lanthanum content.**Experimental:** In the temperature range of 50–300 K, the thermal conductivity of single crystal Ba_{1-x}La_xF_{2+2x} samples with lanthanum content from $x = 0.001$ to $x = 0.300$ was determined by the experimental method of long heat flow.**Conclusions:** A monotonic concentration dependence of thermal conductivity has been revealed. A semi-empirical expression has been proposed to approximate the experimental values of thermal conductivity.**Keywords:** Barium difluoride, Lanthanum, Solid solution, Defect clusters, Thermal conductivity, Semi-empirical model**For citation:** Popov P. A., Shchelokov A. V., Mitroshenkov N. V., Kushnereva A. A., Konyushkin V. A., Nakladov A. N., Fedorov P. P., Kuznetsov S. V. Semi-empirical description of the regularity of change in thermal conductivity of single crystals based on the example of a concentration series of Ba_{1-x}La_xF_{2+2x} solid solutions. *Condensed Matter and Interphases*. 2026;28(1): 92–102. <https://doi.org/10.17308/kcmf.2026.28/13561>

Research article

<https://doi.org/10.17308/kcmf.2026.28/13562>**Features of equilibrium uranium sorption on the fibrous carboxylated sorbent FORPAN from carbonate-containing solutions simulating seawater**

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Abstract**Objectives:** The purpose of this work is to study and identify the features of the equilibrium sorption of uranium from carbonate-containing solutions on a fibrous sorbent obtained (at the St. Petersburg Institute of Textile and Light Industry named after S. M. Kirov) by synthesizing carboxylated polyacrylonitrile (PAN) fiber with formaldehyde, with the common name of FORPAN.**Experimental:** The equilibrium sorption of uranium by the carboxylated fibrous sorbent FORPAN from carbonate-containing solutions simulating seawater was studied in the range of initial concentrations ($3.36 \cdot 10^{-5}$ – $7.13 \cdot 10^{-4}$ mol/l) and temperatures (293–338 K) at pH = 7.85. It was found that during the contact of the fiber with the carbonate-containing uranium solution, a sharp decrease in the pH of the solution and the cleavage of the tricarbonat uranium complex occur due to the protolysis of carboxyl groups. Based on mathematical processing (using the least squares method) of the dependences of the equilibrium distribution coefficients of uranium (ml/g) on the equilibrium concentration of uranium in solution (mol/ml) at different temperatures, a generalized equation was obtained that made it possible to calculate the capacity of the fiber for uranium (mol/g) during its sorption from model solutions prepared based on Caspian Sea water in the range of studied concentrations and temperatures, as well as to calculate the capacity of the FORPAN sorbent relative to uranium in Caspian Sea water ($1.22 \cdot 10^{-5}$ mol/g = $2.9 \cdot 10^{-5}$ g/g) and the distribution coefficient of uranium in seawater ($1.6 \cdot 10^4$ ml/g) at $T = 293.3$ K.**Conclusions:** Based on the conducted studies of the features of equilibrium sorption of uranium from model carbonate-containing solutions and the results obtained, FORPAN fiber can be recommended for the extraction uranium from dilute carbonate-containing solutions of natural waters, in particular from Caspian Sea water, with a uranium content of $2.5 \cdot 10^{-6}$ mol/l, in the range of relatively low temperatures of 293–307 K.**Keywords:** Sorption, Uranium, Fibrous sorbent, Carbonate-containing solutions, Thermodynamics**For citation:** Rahimli M. A., Mamedova S. R. Features of equilibrium uranium sorption on the fibrous carboxylated sorbent FORPAN from carbonate-containing solutions simulating seawater. *Condensed Matter and Interphases*. 2026;28(1): 103–114. <https://doi.org/10.17308/kcmf.2026.28/13562>

Research article

<https://doi.org/10.17308/kcmf.2026.28/13563>**Stability against crystallization and optical properties of (Ga₁₀Ge₁₅Te₇₅)_{100-x}(AgI)_x ($x = 0$ –15 mol %) glasses**E. A. Tyurina¹, A. P. Velmuzhov¹, M. V. Sukhanov¹, A. D. Plekhovich¹, D. G. Fukina², V. S. Shiryaev¹¹G. G. Devyatikh Institute of Chemistry of High-Purity Substances of the Russian Academy of Sciences,

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Abstract**Objectives:** Germanium telluride based glasses, due to their wide transparency range and high refractive index, are promising optical materials for the middle infrared range. The tendency of such glasses to crystallize, which limits their practical application, requires the search for new compositions and the study of their properties. The aim of this work was to investigate the stability against crystallization and optical transparency of (Ga₁₀Ge₁₅Te₇₅)_{100-x}(AgI)_x ($x = 0$ –15 mol %) glasses as new materials for fiber optics.**Experimental:** The glasses were analyzed using differential scanning calorimetry, scanning electron microscopy combined with X-ray spectral microanalysis, and near- and mid-infrared spectroscopy. The main goal of the work is the establishment of high stability against crystallization of the studied glasses with a silver iodide content of 5–15 mol %.**Conclusions:** This makes it possible to consider such glasses as one of the most promising materials for the production of fibers with low

optical losses in the spectral range of 4–15 μm .

Keywords: Chalcogenide glass, Germanium telluride, Silver iodide, Crystallization, Middle infrared materials, Optical transmittance

Funding: The work was financially supported by the Russian Science Foundation (Project No. 25-13-20046, Russia), <https://rscf.ru/project/25-13-20046/>.

For citation: Tyurina E. A., Velmuzhov A. P., Sukhanov M. V., Plekhovich A. D., Fukina D. G. Stability against crystallization and optical properties of $(\text{Ga}_{10}\text{Ge}_{15}\text{Te}_{75})_{100-x}(\text{AgI})_x$ ($x = 0\text{--}15$ mol %) glasses. *Condensed Matter and Interphases*. 2026;28(1): 115–125. <https://doi.org/10.17308/kcmf.2026.28/13563>

Research article

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MOCVD and ferromagnetic resonance of epitaxial $\text{Lu}_3\text{Fe}_5\text{O}_{12}$ films for high-frequency applications

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Abstract

Objectives: The production of thin films of rare earth iron garnets with a narrower ferrimagnetic resonance (FMR) linewidth is extremely important in the development of spintronic materials. Among rare earth iron garnets, the compound $\text{Lu}_3\text{Fe}_5\text{O}_{12}$, which has the highest saturation magnetization, is promising. The aim of this work is to study the dependence of the FMR linewidth of $\text{Lu}_3\text{Fe}_5\text{O}_{12}$ iron garnet films on the lattice mismatch between the film and the substrate, as well as on the film thickness during their production by metalorganic chemical vapor deposition (MOCVD).

Experimental: Thin films of $\text{Lu}_3\text{Fe}_5\text{O}_{12}$ garnet were obtained by MOCVD technique on isostructural single-crystal substrates of $\text{Nd}_3\text{Ga}_5\text{O}_{12}$ (111), $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ (111), $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ (210), $\text{Gd}_3(\text{AlGa}_4)\text{O}_{12}$ (111) and $\text{Y}_3\text{Al}_5\text{O}_{12}$ (111). The films were studied by XRD, EDX, and FMR methods. The dependences of the FMR linewidth on the mismatch of the unit cell (UC) parameters of the garnet at the film–substrate interface, substrate orientation, and film thickness were studied.

Conclusions: It has been established that the minimum FMR linewidth (ΔH) of $\text{Lu}_3\text{Fe}_5\text{O}_{12}$ films is achieved on substrates with minimal mismatch at the interface. The dependence of ΔH on film thickness is shown to be extreme, with the minimum corresponding to a film thickness at which significant relaxation of epitaxial stresses has occurred, but the concentration of defects characteristic of the polycrystalline state is still low. Taking these factors into account will make it possible to obtain iron garnet films with a narrower ferromagnetic resonance linewidth, which can subsequently be used in various areas of spintronics as sensitive elements in microwave detectors.

Keywords: Thin films, Iron garnet, MOCVD, Structure, Ferrimagnetic resonance

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Short communication

Short communication

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Lead-free smart materials based on alkali metal niobates: phase formation, crystal structure, macroscopic responses

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Abstract

Objectives: In the global practice of researching various materials for piezoelectric devices, one of the first places is occupied by functional (smart) materials based on lead-containing compositions. However, the transition to environmentally friendly products, necessitated by the formation of new Russian and European legislative frameworks, has forced the search for other materials science solutions by eliminating lead from the elemental base of materials. An alternative to known compositions are solid solutions based on alkali metal niobates from morphotropic heterophase regions of the corresponding binary and ternary systems, characterized by extreme properties near the interphase boundaries. However, they have not found wide application in practice due to difficulties in phase formation during synthesis and the formation of a dense ceramic framework during sintering.

Experimental: In this work, using mechanical activation and hot pressing procedures, which were not previously used in such environments, it was possible to obtain lead-free, non-toxic ferroelectric piezoelectric ceramics with improved macroscopic responses due to the transformation of the phase coexistence regions.

Conclusions: As a result of the research, multi-frequency materials have been developed and created, including those with an elevated Curie temperature, piezoelectric sensitivity, thermal stability, and pyroelectric effect for various piezoelectric applications.

Keywords: Lead-free piezoceramics, Alkali metal niobates, Solid solutions, Interphase boundaries, Mechanical activation, Hot pressing

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Electronic structure and spatial architecture of chemically deposited high-phosphorus nickel coatings for application in advanced microelectronics technologies

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Abstract

Objectives: This article examines the suitability of chemically deposited high-phosphorus nickel-phosphorus coatings as barrier layers for Through-Silicon Via (TSV) technology. Energy-dispersive X-ray microanalysis revealed that the phosphorus content in the coating is 10.2 wt. % (17.8 at. %). This high phosphorus concentration ensures the coating remains in an amorphous state, which is a critical prerequisite for effective barrier performance.

Experimental: Using X-ray photoelectron spectroscopy and soft X-ray spectroscopy, it was determined that the spherical globular formations comprising the coating have a core-shell structure. It was also demonstrated that the phosphorus concentration in the shell is higher than in the core.

Conclusions: The results obtained are of significant interest for advancing modern semiconductor manufacturing technologies, particularly in the area of heterogeneous 3D integration.

Keywords: Electroless nickel plating, High-phosphorus nickel coatings, Barrier layer, TSV technology, Heterogeneous 3D integration

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Short communication

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Detection of acetone by a sensor based on clinoptilolite

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Abstract

Objectives: The active development of bioreactors used in a wide range of biotechnological, medical, agricultural, and environmental applications requires improvements in their components, including gas-sensitive sensors for various metabolites. Particular preference is given to sensors that are capable of recognizing the composition of complex gas mixtures without the use of bulky and expensive structures.

Experimental: Zeolite-based sensors are a promising technology. The ion conductivity relaxation curves of zeolites under the application of step voltage pulses are considered. The power dependence of the ion conductivity current over time is shown with parameters depending on the sorption of acetone vapors.

Conclusions: The results obtained demonstrate the possibility of using gas-sensitive sensors based on clinoptilolite for the detection of acetone, which is important for their use in microbioreactors.

Keywords: Clinoptilolite, Zeolite, Acetone, Gas-sensitive sensor, Microbioreactor, Ionic conductivity

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Short communication

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***E. coli* cells as a source of biohybrid material: electron microscopy and microanalysis study**

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Abstract

Objectives: The work relates to the research of *E. coli* cells formed under conditions of superproduction of the bacterioferritin protein Dps. These protein molecules are capable of forming biohybrid structures by accumulating inorganic nanoparticles of the iron-oxygen system with identical properties, including sizes within the nanometer range, in their internal cavities. Current methods of obtaining bacterioferritin Dps protein molecules rely on destroying their source: *E. coli* cells. A key issue for study and subsequent application is establishing whether it is possible to obtain these protein molecules without destroying *E. coli* cells in order to form biohybrid structures.

Experimental: *E. coli* cells were grown under conditions of superproduction of bacterioferritin Dps protein molecules, then deposited on a molybdenum foil substrate for electron microscopy and energy-dispersive microanalysis studies. Based on the resulting data on morphology data and elemental composition, the possibility of forming protein molecules without destroying the cells was investigated in order to create biohybrid structures based on them.

Conclusions: It has been established that under conditions of protein superproduction, *E. coli* cells produce bacterioferritin Dps molecules, with a significant amount of this protein possibly being released into the extracellular space. The morphology of *E. coli* cells themselves does not change under conditions of superproduction and protein emission. When Mohr's salt was added to the culture fluid, the released protein contains a significant amount of iron atoms, which may result from bacterioferritin Dps molecules forming biohybrid structures. These results demonstrate a simple, affordable method of forming biohybrid structures containing iron-oxygen nanoparticles for use in technologies, including the targeted delivery of nanoparticles and the functionalization of accessible surfaces.

Keywords: *E. coli* cells, Dps protein molecules, Protein superproduction, Biohybrid material, Scanning electron microscopy, Energy-dispersive microanalysis, Morphology and composition

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