



Аннотации на английском языке

Review

Review article

<https://doi.org/10.17308/kcmf.2022.24/9850>**Selective ion-exchange sorbents for caesium extraction from alkaline radioactive solutions. Review**

V. A. Ivanov, S. I. Kargov, O. T. Gavlina

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Abstract

This review covers studies dedicated to the search for and development of sorbents for the extraction of the caesium-137 radioactive isotope from highly mineralised, highly alkaline solutions that are waste products of nuclear plants. This isotope with a half-life of 30.2 years is one of the most significant contributors to the radioactivity of the waste. It was shown that phenolic sorbents play the key role in caesium extraction from such solutions, they are able to exchange ions on phenolic groups in alkaline solutions, exhibiting high selectivity to caesium against large amounts of sodium and potassium ions. The sorbents make it possible to filter large solution flows, as well as to elute concentrated caesium quantitatively and rapidly with a small volume of acid. We compared the selectivity of sorbents obtained by the condensation of phenol and diatomic phenols with formaldehyde as well as modern materials obtained by the condensation of calixarenes and resorcinarenes with aldehyde. It was shown that the latter do not have any advantage in selectivity and are of lower chemical stability. Therefore, resorcinol-based materials are considered the key element in solving the problem of extracting the caesium-137 isotope from alkaline solutions. We analysed the current state of the problem. This article explains the nature of the high selectivity of phenolic sorbents for caesium ions and why the special arrangement of functional groups of calixarene and resorcinarene resins does not result in increased selectivity as compared with conventional phenol- and resorcinol-based materials.

Keywords: caesium-137 isotope, highly mineralised alkaline solutions, ion exchange, sorption, selectivity, resorcinol-formaldehyde resin, calixarene, resorcinarene

Funding: The work was carried out as part of the project “Molecular and supramolecular structure of individual substances, hybrid and functional materials” (state-funded, section 0110 (for the topics under the state project), Centre of Information Technology and Systems for Executive Authorities number 121031300090-2).

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Для цитирования: Иванов В. А., Каргов С. И., Гавлина О. Т. Селективные ионообменные сорбенты в решении проблемы извлечения цезия из щелочных радиоактивных растворов. *Конденсированные среды и межфазные границы*. 2022;24(3): 287–299. <https://doi.org/10.17308/kcmf.2022.24/9850>

Original articles

Research article

<https://doi.org/10.17308/kcmf.2022.24/9851>**Influence of magnetron sputtering conditions on the structure and surface morphology of $\text{In}_x\text{Ga}_{1-x}\text{As}$ thin films on a GaAs (100) substrate**O. V. Devitsky^{1,2}, A. A. Zakharov², I. S. Lunin^{1,2}, I. A. Sysoev², A. S. Pashchenko^{1,2}, D. S. Vakalov², O. M. Chapura²¹Federal Research Center Southern Scientific Center of the Russian Academy of Sciences, 41 Chekhov str., Rostov-on-Don 344006, Russian Federation²North Caucasian Federal University, 1 Pushkina str., Stavropol 355017, Russian Federation**Abstract**

We present the results of the study of the structure and surface morphology of $\text{In}_x\text{Ga}_{1-x}\text{As}$ thin films on a GaAs substrate. Thin films were obtained by magnetron sputtering from a specially formed $\text{In}_{0.45}\text{Ga}_{0.55}\text{As}$ target in an argon atmosphere.

The obtained samples of thin films were studied by Raman scattering, atomic force microscopy, scanning electron microscopy, and energy-dispersive X-ray spectroscopy. It was shown that the grains of the films obtained at a substrate temperature below 600 °C were not faceted and were formed through the coalescence of grains with a size of 30–65 nm. At a substrate temperature of 600 °C, films consisted of submicron grains with a visible faceting.

It was determined that the average grain size increased and the root-mean-square roughness of thin films decreased due to an increase in the substrate temperature. Thin films obtained at a substrate temperature of 600 °C possessed the best structural properties.

Keywords: Magnetron sputtering, Thin films, Raman scattering, Surface morphology, A^3B^5 compounds

Funding: The study received financing within the framework of state order of the Federal Research Centre Southern Scientific Centre of the Russian Academy of Sciences, state registration number 122020100326-7. It was conducted utilising the equipment of the centre for collective use of the North-Caucasus Federal University and supported by the Ministry of Science and Higher Education of Russia, unique project identifier RF-2296.61321X0029 (agreement No. 075-15-2021-687).



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Для цитирования: Девидский О. В., Захаров А. А., Лунин Л. С., Сысоев И. А., Пашченко А. С., Вакалов Д. С., Чапура О. М. Влияние условий магнетронного распыления на структуру и морфологию поверхности тонких пленок $\text{In}_x\text{Ga}_{1-x}\text{As}$ на подложке GaAs (100). *Конденсированные среды и межфазные границы*. 2022;24(3): 300–305. <https://doi.org/10.17308/kcmf.2022.24/9851>

Research article

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Synthesis of magnetic chromium substituted cobalt ferrite $\text{Co}(\text{Cr}_x\text{Fe}_{1-x})_2\text{O}_4$ adsorbents for phosphate removal
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Huu Thinh Pham Nguyen^{1,2}, Anh Tien Nguyen³, Quoc Thiet Nguyen⁴, Tien Khoa Le^{1,2}

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Abstract

In this work, we aimed to prepare chromium substituted cobalt ferrite $\text{Co}(\text{Cr}_x\text{Fe}_{1-x})_2\text{O}_4$ powders by a simple coprecipitation-annealing method with different Cr contents to create novel magnetic adsorbents for the removal of phosphate ions from water. The effects of Cr substitution on the crystal structure, phase composition, morphology, surface atomic composition, surface area and magnetic properties of our adsorbents were investigated by X-ray diffraction, scanning electron microscopy, energy-dispersive X-ray spectroscopy, Brunauer-Emmett-Teller nitrogen adsorption-desorption and vibrating sample magnetometry. According to the results, all our $\text{Co}(\text{Cr}_x\text{Fe}_{1-x})_2\text{O}_4$ samples exhibited higher phosphate adsorption than CoFe_2O_4 powder but their magnetic properties were reduced for increasing Cr substitution. Among them, the $\text{Co}(\text{Cr}_{0.25}\text{Fe}_{0.75})_2\text{O}_4$ sample was found to be the most promising material since its magnetic properties are still high to allow it to be easily separated from the solution and its maximum P adsorption capacity (according to the Langmuir model) was estimated to be 4.84 times higher than CoFe_2O_4 , which can be attributed to the presence of Cr^{3+} ions on the surface and the enhanced surface specific area of this substituted sample. Moreover, the adsorption data of $\text{Co}(\text{Cr}_{0.25}\text{Fe}_{0.75})_2\text{O}_4$ sample also fitted well to the pseudo second order kinetic model, revealing the adsorption rate constant of $0.87 \text{ mgP}^{-1}\text{s}^{-1}$, two times superior to CoFe_2O_4 .

Keywords: Chromium substitution; Cobalt ferrite; Phosphate removal; Magnetic adsorbent; Surface Cr^{3+} content

For citation: Tran Q. A., Tran N. L., Nguyen A. D. K., Le T. Q. N., Nguyen L. T., Nguyen H. T. P., Nguyen A. T., Nguyen T., Q., Le T. K. Synthesis of magnetic chromium substituted cobalt ferrite $\text{Co}(\text{Cr}_x\text{Fe}_{1-x})_2\text{O}_4$ adsorbents for phosphate removal. *Condensed Matter and Interphases*. 2022;24(3): 306–314. <https://doi.org/10.17308/kcmf.2022.24/9852>

Для цитирования: Чан К. А., Чан Н. Л., Нгуен А. Д. К., Ле Т. К. Н., Нгуен Л. Т., Нгуен Ч. Т. Ф., Нгуен А. Т., Нгуен Т. К., Ле Т. К. Синтез магнитных адсорбентов хромзамещенных ферритов кобальта $\text{Co}(\text{Cr}_x\text{Fe}_{1-x})_2\text{O}_4$ для удаления фосфатов. *Конденсированные среды и межфазные границы*. 2022;24(3): 306–314. <https://doi.org/10.17308/kcmf.2022.24/9852>

Research article

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The effect of the moisture content in benzoic acid on the electrical conductivity of its melts

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Abstract

The purpose of our study was to analyse the effect of the moisture content in benzoic acid on the electrical conductivity of its melts.

The measurements were performed using impedance spectroscopy in a hermetically sealed metal cell with the temperature of the melts being 160–200 °C. Samples of benzoic acid with different moisture content were used: (i) as-received benzoic acid; (ii) acid dried over anhydrous calcium chloride; (iii) acid exposed to air at 100 % relative humidity.

The study demonstrated that electrical conductivity increased with an increase in the amount of moisture in the acid (the conductivity of the sample with the highest moisture content was about 2.5 times higher than that of the driest sample).

The results obtained are of importance for understanding the mechanisms of proton exchange processes on lithium niobate crystals and can be used for the production of proton-exchange waveguides with stable characteristics.

Keywords: electrical conductivity, benzoic acid, melt, moisture, proton exchange

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Research article

<https://doi.org/10.17308/kcmf.2022.24/9854>**The influence of the structure of carbon nanotubes in the polymer matrix on interfacial effects in nanocomposites**

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It is now a well-known fact that interfacial effects play a decisive role in the formation of the properties of polymer composites on the whole and nanocomposites in particular. Therefore, this article investigates the relations between the structure of carbon nanotubes in the polymer matrix of a nanocomposite and the level of interfacial adhesion which is characterised by dimensionless parameter b_a .

It was shown that carbon nanotubes form ring-like structures, which are analogous to macromolecular coils of branched polymer chains and represent a specific type of aggregates for nanofillers of this type. Such ring-like structures can be geometrically described either by a full circle ("closed" structures) or by a part of it (arc) ("open" structures). The amplification of the aggregation process of carbon nanotubes characterised by a decrease in the radius of the ring-like structures is accompanied by a decrease in the fractal dimension of their surface compared to the nominal maximum value. When the ring-like structures reach the smallest possible (about 130 nm) radius, their surface is perceived by the polymer matrix as absolutely smooth, i.e. with a dimension of $d=2$. This determines the transition of the level of interfacial adhesion from nanoadhesion to perfect adhesion by Kerner. The nanoadhesion effect allows significantly improving the properties of polymer/carbon nanotube nanocomposites. The nanoadhesion effect only takes place if the surface of the ring-like structures of nanotubes is fractal.

Parameter b_a , which characterises the level of interfacial adhesion in polymer nanocomposites, linearly increases with an increase in the fractal dimension of the surface of carbon nanotube aggregates. In this case, the highest attainable nominal dimension of the nanotubes surface, equal to ~ 2.85 , is only achieved for "open" ring-like structures. The proposed analytical methods make it possible to predict both interfacial characteristics and the properties of polymer/carbon nanotube nanocomposites.

Keywords: nanocomposite, carbon nanotubes, ring-like structures, aggregation, interfacial adhesion, surface, fractal dimension

For citation: Kozlov G. V., Dolbin I. V. The influence of the structure of carbon nanotubes in the polymer matrix on interfacial effects in nanocomposites. *Condensed Matter and Interphases*. 2022; 24(2): 321–325. <https://doi.org/10.17308/kcmf.2022.24/9854>

Для цитирования: Козлов Г. В., Долбин И. В. Влияние структуры углеродных нанотрубок в полимерной матрице на межфазные эффекты в наноккомпозитах. *Конденсированные среды и межфазные границы*. 2022; 24(2): 321–325. <https://doi.org/10.17308/kcmf.2022.24/9854>

Research article

<https://doi.org/10.17308/kcmf.2022.24/9855>**Structural-phenomenological analysis of interrelation of microstructure indexes and properties of set cement systems**A. A. Ledenev¹, V. T. Pertsev², O. B. Rudakov², S. M. Usachev²*¹Air Force Military Educational and Scientific Center «Air Force Academy
named after Professor N. E. Zhukovsky and Y. A. Gagarin» (Voronezh),
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84 20-letiya Oktyabrya str., Voronezh 394006, Russian Federation***Abstract**

The study of the chemical and physical processes of solidification of polydisperse cement systems until now is based predominantly on empirical approaches. The phenomenological analysis of the interrelation of structure coefficients of set cement systems at the microlevel with their physical-mechanical properties was proposed as one of scientifically-practical approaches to control of physical and chemical processes of structure formation of controlled-quality concretes. The comparison of the quantity indicators of a microstructure of cement rock and its functional properties can be used for the estimation of structural modifications with a variation in the composition of cement systems. The aim of the study was to obtain quantitative data of the structural-phenomenological analysis of set cement systems for determination of interrelation of microstructure indexes with their physical-mechanical properties.

For the analysis of the structure of cement systems we used fractal geometry and the theory of passing (percolation)-based methods as well as modern modelling methods and scanning electronic and atomic-power microscopy. Fractal index D and micro-coarseness index S were used for a quantitative estimation of the microstructure of cement rock obtained without an additive and with an organomineral additive. These indexes were compared with the properties of cement rock determined during standard physical-mechanical trials.

The calculation of microstructure indicators and determination of the optimal content of the components of the organomineral additive allowed increasing the understanding of the fractal-cluster mechanism of self-organization of cement systems, taking into account the topology of particle distribution. The interrelation between the D and S indicators, compressive resistance and the density of the cement stone was shown. The higher fractal parameter and a relatively low level of micro-coarseness were indicators of the material with improved physical-mechanical properties. The monitoring of changes of D and S indicators can be used to control the structural formation processes of cement systems.

Keywords: Polydisperse cement systems, Fractal-cluster microstructures, Electron microscopy, Fractality, Micro-coarseness, Physical-mechanical properties

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Для цитирования: Леденев А. А., Перцев В. Т., Рудаков О. Б., Усачев С. М. Структурно-феноменологический анализ взаимосвязи показателей микроструктуры и свойств затвердевших цементных систем. *Конденсированные среды и межфазные границы*. 2022;24(3): 326–334. <https://doi.org/10.17308/kcmf.2022.24/9855>

Research article

<https://doi.org/10.17308/kcmf.2022.24/9856>**Phase equilibria in the MnTe–MnGa₂Te₄–MnIn₂Te₄ system**F. M. Mammadov^{1,2}, S. Z. Imamaliyeva¹, Ya. I. Jafarov², I. B. Bakhtiyarly¹, M. B. Babanly¹¹Institute of Catalysis and Inorganic Chemistry n.a. M. Nagiyev of the Azerbaijan National Academy of Sciences, 113 H. Javid av., Baku Az1143, Azerbaijan²Baku State University,

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Abstract

A family of compounds with the general formula AB₂X₄ (A – Mn, Fe, Co, Ni; B – Ga, In, Sb, Bi; X – S, Se, Te) and complex phases of variable compositions based on them are among promising functional materials with thermoelectric, photoelectric, optical, and magnetic properties. In this article, we continued the study of multi-component systems based on the chalcogenides of transition metals and presented the results of the study of phase equilibria in the MnTe–MnGa₂Te₄–MnIn₂Te₄ system using differential thermal analysis and X-ray phase analysis.

Based on the experimental results, we built the polythermal cross sections MnTe–MnGaInTe₄ and MnGa₂Te₄–[A] (where [A] is a biphasic alloy of the 2MnTe–MnIn₂Te₄ side system of the 50.0 mol% MnIn₂Te₄ composition) as well as an isothermal section of a phase diagram at 800 K and a projection of the liquidus surface. It was established that the liquidus consists of the fields of primary crystallisation of 4 phases: 1 – Mn-ht; 2 – phases based on various modifications of MnTe; 3 – γ_1 ; 4 – γ_2 . We also identified types and coordinates of non-variant and monovariant equilibria.

Based on triple compounds (MnGa₂Te₄, MnIn₂Te₄), we determined wide regions of solid solutions that are of particular interest as magnetic materials.

Keywords: Manganese-gallium telluride, Manganese-indium telluride, Phase diagram, Liquidus surface, Solid solutions, Magnetic materials

Funding: The study was carried out within the framework of the scientific programme of the international laboratory “Promising materials for spintronics and quantum computing”, created at the Institute of Catalysis and Inorganic Chemistry of Azerbaijan National Academy of Sciences (Azerbaijan) and the Donostia International Physics Center (Spain) and with the partial financial support of the Science Development Foundation under the President of the Republic of Azerbaijan – grant EIF-BGM-4-RFTF-1(2017)-21/11/4-M-12.

For citation: Mammadov F. M., Imamaliyeva S. Z., Jafarov Ya. I., Bakhtiyarly I. B., Babanly M. B. Phase equilibria in the MnTe–MnGa₂Te₄–MnIn₂Te₄ system. *Condensed Matter and Interphases*. 2022;24(3): 335–344. <https://doi.org/10.17308/kcmf.2022.24/9856>

Для цитирования: Мамедов Ф. М., Имамалиева С. З., Джафаров Я. И., Бахтиярлы И. Б., Бабанлы М. Б. Фазовые равновесия в системе MnTe–MnGa₂Te₄–MnIn₂Te₄. *Конденсированные среды и межфазные границы*. 2022;24(3): 335–344. <https://doi.org/10.17308/kcmf.2022.24/9856>

Research article

<https://doi.org/10.17308/kcmf.2022.24/9857>**Synthesis of chemically pure β -phase powders of gallium(III) oxide**

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Abstract

The purpose of our study was to develop an optimal procedure for the synthesis of the β -phase of gallium(III) oxide with a high degree of chemical purity. Based on the analysis of the possible synthesis methods of the β -phase of gallium(III) oxide, we suggested a procedure which uses gallium(III) nitrate crystalhydrate as a precursor for obtaining the final product. The article demonstrates that during the synthesis of gallium(III) nitrate by means of direct interaction between metallic gallium and concentrated nitric acid, a hygroscopic crystalhydrate is formed with the formula Ga(NO₃)₃·9H₂O.

Powders of the β -phase of Ga₂O₃ were synthesised by means of the thermal decomposition of gallium(III) nitrate in an oxygen atmosphere. Electron probe microanalysis (EPMA) and X-ray phase analysis (XRD) were used to determine the quantitative chemical composition, stoichiometry, and crystal structure of the gallium(III) oxide samples synthesised at different temperatures. The EPMA of the powders calcinated at temperatures $T_{\text{calc}} = 500\text{--}950$ °C demonstrated that the ratio of the elements was constant and corresponded to the stoichiometric composition of Ga₂O₃. A comparative analysis of the X-ray diffraction peaks demonstrated that with an increase in the decomposition temperature within the range $T_{\text{calc}} = 500\text{--}950$ °C, the symmetry of the structure of the Ga₂O₃ powders decreased from the cubic to the monoclinic. The study also determined that the samples of gallium(III) oxide synthesised at $T_{\text{calc}} = 950$ °C are single-phase and consist entirely of the monoclinic β -phase. The XRD data was used to calculate the crystal lattice parameters of the samples of the β -phase of Ga₂O₃ synthesised at $T_{\text{calc}} = 950$ °C.

Keywords: Gallium (III) oxide, Gallium (III) nitrate, Polymorphous modifications, Stoichiometry, Crystal structure, Monoclinic crystal system, Lattice parameters

Funding: The work was supported by the Ministry of Science and Higher Education of the Russian Federation in the framework of the government order to higher education institutions in the sphere of scientific research for years 2020-2022, project No. FZGU-2020-0036.

Acknowledgements: Powder diffraction and electron probe microanalysis were carried out using the equipment of the Centre for the Collective Use of Scientific Equipment of Voronezh State University.

For citation: Samoylov A. M., Kopytin S. S., Oreshkin K.V., Shevchenko E. A. Synthesis of chemically pure powders of β -phase of gallium(III) oxide. *Condensed Matter and Interphases*. 2022;24(3): 345–355. <https://doi.org/10.17308/kcmf.2022.24/9857>

Для цитирования: Самойлов А. М., Копытин С. С., Орешкин К. В., Шевченко Е. А. Синтез химически чистых порошков β -фазы оксида галлия (III). *Конденсированные среды и межфазные границы*. 2022;24(3): 345–355. <https://doi.org/10.17308/kcmf.2022.24/9857>

Research article

<https://doi.org/10.17308/kcmf.2022.24/9858>**Engineering of biomimetic composite dental materials based on nanocrystalline hydroxyapatite and light-curing adhesive**
P. V. Seredin¹, D. L. Goloshchapov¹, Asaad A. H. AlZubaidi², V. M. Kashkarov¹, N. S. Buylov¹, Yu. A. Ippolitov³, J. Vongsvivut⁴¹Voronezh State University,

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Abstract

With the use of light-curing Bis-GMA (Bis-phenol-A glycidylmethacrylate) adhesive and nanocrystalline carbonate-substituted calcium hydroxyapatite (nano-cHAp), corresponding by an aggregate set of characteristics to the apatite of human enamel and dentin obtained from the biogenic source of calcium – egg's shell of birds biomimetic Bis-GMA/nano-cHAp adhesives were synthesized.

Introduction and distribution of nano-cHAp filler in the adhesive matrix as well as its interaction with molecular groups of the latter one resulted in the change of chemical bonds that was evidenced by the data of Fourier transform infrared (FTIR) spectroscopy. In summary, for the specified nanofiller concentration increased values of Vicker hardnesses (VH) and degree of conversion were attained simultaneously while light curing of Bis-GMA/nano-cHAp adhesive.

This result would provide a considerable influence on the following application of the developed biomimetic adhesives and clinical successes of teeth restoration with the use of these composites.

Keywords: Biomimetic strategies; Nanodentology; Calcium hydroxyapatite; Adhesives**Funding:** This work was supported by the grant of Russian Science Foundation, grant number 21-15-00026.

The access to scientific equipment and methodology was provided under support of the Ministry of Science and Higher Education of Russia, Agreement N 075-15-2021-1351.

Data availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.**Acknowledgments:** The part of this research was undertaken with The Infrared Microspectroscopy (IRM) beamline at the Australian Synchrotron.**For citation:** Seredin P. V., Goloshchapov D. L., AlZubaidi Asaad A. H., Kashkarov V. M., Buylov N. S., Ippolitov Yu. A., Vongsvivut J. Engineering of biomimetic composite dental materials based on nanocrystalline hydroxyapatite and light-curing adhesive. *Condensed Matter and Interphases*. 2022;24(3): 356–361. <https://doi.org/10.17308/kcmf.2022.24/9858>**Для цитирования:** Середин П. В., Голощчапов Д. Л., Альзубайди Асаад А. Х., Кашкаров В. М., Буйлов Н. С., Ипполитов Ю. А., Вонгсвивут Дж. Разработка биомиметических композитных стоматологических материалов на основе нанокристаллического гидроксиапатита и светоотверждаемого адгезива. *Конденсированные среды и межфазные границы*. 2022;24(3): 356–361. <https://doi.org/10.17308/kcmf.2022.24/9858>

Research article

<https://doi.org/10.17308/kcmf.2022.24/9859>**Effect of pore size on phase transitions in rubidium tetrachlorozincate nanoparticles in porous glass matrices**L. S. Stekleneva^{1,3}, A. A. Bryanskaya¹, M. A. Pankova², S. V. Popov³, L. N. Korotkov¹¹Voronezh State Technical University,

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Abstract

It is well known that below a certain temperature (T_i), local displacements of individual atoms from their original positions occur in ferroelectric crystals with incommensurate phases. They form a spatial wave with a length of λ , which is incommensurate with the lattice period a , i.e. the λ/a ratio is irrational. The wavelength increases as the temperature decreases. Near the phase transition temperature T_c , it reaches a length comparable to the size of the ferroelectric domains, as in the model rubidium tetrachlorozincate crystal (Rb_2ZnCl_4). In ultrafine Rb_2ZnCl_4 crystals, the increase in λ is hindered by the size of the crystallite. Therefore, the physical properties of nanocrystalline rubidium tetrachlorozincate are expected to be considerably different from those of the bulk sample.

One of the methods for producing nanosized ferroelectric materials is a method based on embedding the material from a solution into porous matrices with nanometre-sized through-pores. We applied this method to study the effect of the size of ultrafine rubidium tetrachlorozincate crystallites on its dielectric properties and the phases occurring in the nanocrystallites.

For the experiment, we used samples of polycrystalline Rb_2ZnCl_4 and composites obtained by incorporation of Rb_2ZnCl_4 salt from aqueous solution into porous silicon oxide matrices with an average through-pore diameter of 46 and 5 nm (RS-46 and RS-5, respectively). The temperature dependencies of their dielectric permittivity were studied within the range of 100 to 350 K. We determined the temperatures of transition to the incommensurate (T_i) and ferroelectric (T_c) phases, as well as the mobility deceleration temperatures of ferroelectric domain boundaries in rubidium tetrachlorozincate nanocrystallites in the RS-46 composite. In Rb_2ZnCl_4 particles in the RS-5 composite, only the transition to the incommensurate phase occurs. In contrast to the bulk material, it shows features of the first-order phase transition.

Keywords: Incommensurate phase, Composite, Porous glass, Ferroelectric phase transition, Dielectric permittivity**Funding:** The study was supported by the Russian Foundation for Basic Research, project no. 19-32-90164.**Acknowledgements:** The authors would like to thank Rysiakiewicz - Pasek E. for porous glass matrices, as well as Kashirin M. A. for his help with the X-ray diffraction experiment.**For citation:** Stekleneva L. S., Bryanskaya A. A., Pankova M. A., Popov S. V., Korotkov L. N. Effect of pore size on phase transitions in rubidium tetrachlorozincate nanoparticles in porous glass matrices. *Condensed Matter and Interphases*. 2022;24(3): 000-000. <https://doi.org/10.17308/kcmf.2022.24/9859>

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Research article

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Analysis of the variations in the surface properties of SiO₂ and Al₂O₃ nanoparticles obtained by different synthesis methods

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Abstract

The article presents a comparative study of the surface properties of silica and alumina nanoparticles synthesized by various methods. Using the IR spectroscopy we demonstrated that the synthesis method affect the surface properties of nanoparticles while maintaining the phase composition of the material. The article demonstrates the relationship between the types of surface sites, their strength, and the interaction of nanoparticles with the dispersed medium. In particular, a significant difference was observed in the strength of the active sites for all samples, which was reflected in the rheology of nanofluids based on epoxy resin. This demonstrates the importance of accurate descriptions of the surface properties of nanoparticles, as they determine their interaction with other materials.

The article also considers the possibility to evaluate the intensity of the particle-medium interaction based on the fractal dimension. Our study showed that it varies significantly depending on the synthesis method. The article discussed the possibility to determine the intensity of the particle-medium interaction using the values of the nanoparticle's zeta potential and the interfacial layer.

Keywords: nanoparticles, surface sites, interfacial layer, zeta potential, nanoparticle synthesis

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Research article

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Influence of the method of formation a nanosized CoFe₂O₄/nontronite composite on its structure and properties

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Abstract

The aim of the study was to establish the influence of the method of formation of the CoFe₂O₄/nontronite nanocomposite on its structure and properties.

Impurity-free nanoparticles of cobalt ferrite CoFe₂O₄ (XRD), close to spherical in shape, with a predominant particle fraction in the range of 8–20 nm (TEM), were synthesized using the citrate combustion method. The formation of the CoFe₂O₄/nontronite nanocomposite was carried out by two methods: mechanical mixing of available precursors followed by annealing and combustion of iron-cobalt citrate with the formation of spinel in the presence of nontronite in the reactor.

The CoFe₂O₄/nontronite nanocomposite formed by the first method is characterized by the decomposition of natural aluminosilicate aggregates and a higher sorption activity with respect to formaldehyde than the original clay mineral and spinel. The second method of composite formation leads to the formation of coarse-grained silica structures with worse sorption activity in comparison with natural aluminosilicate and CoFe₂O₄.

Keywords: Nanocomposite, Citrate combustion method, Cobalt ferrite, Aluminosilicate

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Research article

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Up-conversion luminescence in mixed crystals $\text{BaY}_{1.8}\text{Lu}_{0.2}\text{F}_8$ doped with Er^{3+} ions excited at 1532 nm

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Abstract

Increasing the efficiency of upconversion luminophores is an important problem in materials science. Here we report on approach of use of disordered crystals namely solid solutions $\text{BaY}_{1.8}\text{Lu}_{0.2}\text{F}_8$ doped with Er^{3+} ions to improve spectral characteristics and efficiency of upconversion from near IR spectral region. It is shown that investigated compound provide up to 9.4% of external energy yield of the up-conversion luminescence at an excitation power density of 6 W/cm² at 1532 nm for the 10 at.% of Er^{3+} doping. Also the investigated crystals of $\text{BaY}_{1.8}\text{Lu}_{0.2}\text{F}_8:\text{Er}^{3+}$ allow the control of the CCT parameter in the range of 2384–5149 K by changing the concentration and power density of the excitation. Advantages revealed in this work for crystalline compounds $\text{BaY}_{1.8}\text{Lu}_{0.2}\text{F}_8:\text{Er}^{3+}$ such as wide absorption bands in the infrared spectral range, a high external energy yield, and a controllable distribution of intensity of luminescence bands makes them prospective to improve the efficiency of double-sided solar cells.

Keywords: Upconversion luminescence, External energy yield, Correlated color temperatures, Er^{3+} , Fluoride crystals, Solid solutions

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