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## 1. NANOPHYSICS

### 1.1. Phenomena and Effects

**1.1.1.1. Heavy hole- and light hole-trion states in ellipsoidal quantum dot.** /Y. Bleyan, D. Hayrapetyan/. Nano Studies. – 2019. – #19. – pp. 7-10. – eng.; abs.: eng.

The heavy hole and light hole negative trions, which consist of two electrons bound by a hole, are considered in strongly prolate ellipsoidal quantum dot. Fig. 3, Ref. 9.

**Keywords:** heavy hole, light hole, negative trions, ellipsoidal dot

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**1.1.1.2. Theoretical investigation of the Faraday-rotation effect in atomic alkali nano-layers.** /A. Amiryany/. Proceedings of NAS RA. Physics. – 2018. – v. 53. – #3. – pp. 281-293. – rus.; abs.: rus., arm., eng. Theoretical studies of the Faraday-rotation (FR) effect in alkali vapors contained in extremely thin cells, are presented. It is shown that the spectra of the FR signal are well frequency resolved despite the huge number of atomic transitions. This allows one to study the evolution of the Cs  $D_1$  ( $\lambda = 895$  nm) line hyperfine structure of  $F_g = 4 \rightarrow F_e = 3, 4$  atomic transitions in magnetic fields. The presented theoretical model predicts the coherent Dicke narrowing effect and its revival with a periodicity  $L = \lambda$ . The practical applications of the FR are noted. Fig. 6, Ref. 19.

**Keywords:** Faraday rotation, atomic alkali vapors, nano layers, Dicke effect

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**1.1.1.3. Numerical Study of Josephson nanostructures Using Parallel Computing. (Proceedings of the Int. Conference on “The Problems of Modern Condensed Matter Physics”).** /I. Rahmonov, E. Zemlyanaya, M. Bashashin, P. Atanasova, A. Rahmonova, Yu. Shukrinov/. Armenian Journal of Physics. – 2019. – v. 12. – #3. – pp. 233-239. – rus.; abs.: eng.

We investigate the phase dynamics of the stack of long JJs, the length of which exceeds the Josephson penetration depth  $\lambda_J$ , taking into account the inductive and capacitive couplings between junctions and diffusion current. Numerical simulation of current-voltage characteristics of the stack is based on numerical solution of a system of nonlinear partial differential equations by the fourth order Runge-Kutta method and finite-difference approximation. The calculations are performed using the MPI technique for parallel implementation. The methodical calculations on multi-processor cluster (LIT JINR) with a different number of parallel MPI-processes are carried out. We have shown that the developed parallel algorithm provides about 7 time acceleration in comparison with serial simulation. Fig. 2, Tab. 1, Ref. 22.

**Keywords:** Josephson junction, inductive coupling, capacitive coupling

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## 1.2. Properties of Materials and Structures

**1.1.2.1. Structural studies of polyimide films; size effect.** /V. Geidarov, I. Braude, N. Gal'tsov, Yu. Pohribnaya, V. Lototskaya, N. Aksenova/. Nano Studies. – 2019. – #19. – pp. 11-14. – eng.; abs.: eng. Amorphous polymerized films of 4,4'-difinyleneoxidepyromellitimide with thickness of 125 and 75  $\mu\text{m}$ , after stretching, were investigated by the structural method. The findings of the study results in that stretching of polymer films with thickness of 75  $\mu\text{m}$  do not cause cardinal changes in the structure, while

the deformation of polymer films with thickness of 125  $\mu\text{m}$  leads to the appearance of regions with long-range order in the sample. Fig. 3, Ref. 17.

**Keywords:** polyimide films, side effects, long-range order

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**1.1.2.2. About physical nature of some peculiarities of primary cosmic radiation nuclei and gamma quanta spectra.** /T. Barnaveli, N. Eristavi, I. Khaldeeva/. *Nano Studies.* – 2019. – #19. – pp. 203-212. – eng.; abs.: eng.

About twenty years ago authors published the data concerning some peculiarities of the behavior of cosmic radiation EAS hadron component spectra. The results pointed to the possible existence in the interstellar space of the background of weakly interacting objects of the mass (the energy of the resonance oscillations) of the order of 37 eV. On the other hand, the experimental data of the last years are pointing to the existence of cosmic gamma radiation with the specific spectrum having the steep right front again in the region of the order of 37 eV and the left front falling down to the energies of the order less than  $10^{-6}$  eV. Obviously, no elementary object may possess such spectrum of frequencies or a decay spectrum. Such spectrum may have some certain system or construction consisting of many elements possessing their own resonance frequencies and together composing the spectra observed. The possibility is presented of exactly such explanation of the cosmic rays primary radiation spectra peculiarities experimentally observed. It is based on the hypothesis about the discreteness of the space and existence in it of the topological defects distributed with sufficient density. In the frames of the proposed model some essential experimental peculiarities of the primary cosmic radiation nuclei and gamma quanta spectra find the unified explanation. Fig. 4, Ref. 15.

**Keywords:** cosmic radiation, gamma quanta spectra, EAS hadron, cosmic radiation, spectrum of frequencies

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**1.1.2.3. Interpolation formula of magnetic nanofluids magnetization.** /A. Ugulava, S. Chkhaidze, G. Mchedlishvili, R. Abramishvili/. Nano Studies. – 2019. – #19. – pp. 37-44. – eng.; abs.: eng.

The internal energy of the magnetic anisotropy of some nanoparticles predominates over the thermal energy even at room temperature. It is known that the magnetic anisotropy axes of the magnetic nanofluids of nanoparticles, which in the absence of a magnetic field are oriented at random, at a sufficiently strong magnetic field, are polarized along the magnetic field and the so-called mechanical anisotropy state originates. In this paper, it is shown that the magnetization curve of the subsystem of polarized particles in the case when the anisotropy energy exceeds thermal energy has a special shape similar to the shape of a hyperbolic tangent. In the present model of a magnetic nanofluid it consists of two components (subsystems) with a variable number of particles: a subsystem of particles with randomly directed axes and subsystem of particles with polarized axes. The change of the magnetic field value causes the change of the number of particles in the subsystems followed by the change the magnetization of the whole magnetic nanofluids. For a given value of the magnetic field interpolation formula of magnetic nanofluids magnetization is found from the condition that the chemical potentials of subsystems are equal. It is shown that the magnetization curve obtained on the basis of a two-component model of magnetic nanofluids, is located between the Langevin curve and the hyperbolic tangent and with increasing anisotropy takes progressively the hyperbolic tangent shape. It is also shown that in strong magnetic anisotropy saturated state of magnetization of nanoparticles occurs much earlier than it follows from the Langevin theory. This significantly increases the Curie constant. Fig. 1, Ref. 9.

**Keywords:** interpolation formula, magnetic nanofluids, Langevin curve, Langevin theor

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#### 1.1.2.4. Role of interfaces in spin dynamics and flows in magnetic nanostructures with normal metal sublayers. /A. Korostil/. Nano Studies. – 2019. – #19. – pp. 45-64. – eng.; abs.: eng.

The interconnection between the spin current and spin dynamics via the spin-dependent scattering and an accompanying by spin torque effect in ferromagnetic/normal metal based magnetic multilayer nanostructures is studied including a high fast out-of-equilibrium spin dynamics. Features of the spin transport through interfaces and its impact on spin dynamics are described on the base of the scattering matrix formalism for spin flows. The dependence of the spin torque effect on conductance character of the normal metal layers is considered. The exchange processes between the itinerant  $s$  and the localized  $d$  electrons are described by kinetic rate equations for electron-magnon spin-flop scattering. It is shown that the magnon distribution function remains nonthermalized on the relevant time scales of the demagnetization process, and the relaxation of the out-of-equilibrium spin accumulation among itinerant electrons provides the principal channel for dissipation of spin angular momentum from the combined electronic system. Fig.7, Ref. 48.

**Keywords:** spin dynamics, flow, magnetic nanostructures, magnon distribution, out-of-equilibrium spin

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**1.1.2.5. Activation volume of plastic deformation of ultrafine-grained copper.** /T. Hryhorova/. *Nano Studies*. – 2019. – #19. – pp. 65-76. – eng.; abs.: eng.

Tensile and stress relaxation tests in the temperature range 77-295 K were carried out to study the mechanical properties and kinetics of plastic deformation of ultrafine-grained (UFG) copper prepared by equal-channel angular hydroextrusion. The temperature and strain-rate sensitivities of flow stress were analyzed to identify main mechanisms of plastic deformation. It was shown that as temperature increases the flow stress decreases but the activation volume changes non-monotonously reaching the peak value at about 200 K. In contrast to conventional copper polycrystals both temperature dependencies for UFG copper can be explained in terms of two mechanisms of thermally activated plastic deformation: “forest” intersection and dynamic recovery. The latter mechanism is necessary to take into account for a correct estimation of activation volume from stress relaxation tests even at low temperatures. Tab. 1, Fig. 7, Ref. 25.

**Keywords:** plastic deformation, ultrafine-grained copper, peak value, activation volume

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**1.1.2.6. GaN monolayer films on GaAs surface (001): Obtaining and optical studies.** /V. Berkovits, V. Ulin, G. Iluridze, T. Minashvili, K. Davitadze, A. Gigineishvili, Z. Jabua/. Nano Studies. – 2019. – #19. – pp. 111-114. – rus.; abs.: rus.

Using anisotropic reflection spectroscopy, monolayer films of gallium nitride formed on the GaAs crystals (1) surface were studied by chemical nitriding in hydrazine-sulphide solutions. It was found that the anisotropic reflection spectra of nitrided GaAs samples contain only volume anisotropy signals in the region of the  $E_1$  and  $E_1 + \Delta_1$  transitions in GaAs, and the layer of nitrogen atoms on the surface is optically isotropic. It was shown as well that as a result of nitridation, the bending of zones near the surface of n-type GaAs crystals decreases by ~25%. Fig. 2, Ref. 8.

**Keywords:** gallium nitride (GaN) monolayer, GaAs surface, nitrogen atoms, hydrazine-sulphide solution

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**1.1.2.7. Location of interstitial light atoms in vanadium hydrides (deuterides).** /N. Namoradze, I. Ratishvili/. Nano Studies. – 2019. – #19. – pp. 125-130. – eng.; abs.: eng.

The local mode frequencies of the light atoms inserted in the interstitial positions of a bcc metal lattice are considered. A significant difference between the oscillations of a light atom located in the octahedral and in the tetrahedral interstitial positions is indicated. An example of the  $V_2H(D)$  system is analyzed and it is suggested that the neutron inelastic diffraction experiments indicate that the light atoms are located in the octahedral interstitial positions. Fig. 4, Ref. 12.

**Keywords:** interstitial light atoms, vanadium, neutron inelastic diffraction, octahedral positionb

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**1.1.2.8. On experimental methods for studying of mechanical properties of solids.** /M. Galustashvili, D. Driaev/. *Nano Studies*. – 2019. – #19. – pp. 213-222. – rus.; abs.: rus.

The original experimental methods of studying the mechanical properties and dislocation structure of solids developed at the E. Andronkashvili Institute of Physics are described. Among them are: (a) method of excitation of mechanical vibrations of the ion crystal (for example, LiF) by acting on charged dislocations; (b) method of the vibrating superconductor (for example, the reed of Nb in mixed state) demonstrating the dependence of the effective elastic modulus and dissipation of mechanical energy on the orientation of the Abrikosov vortices relative to the axis of bending of the reed; (c) method for determining the parameters of the relaxation process by measuring the internal friction of the crystal simultaneously at two frequencies of bending vibrations; (d) method of shear deformation in one system of crystallographic planes; and (e) method of bending deformation with dislocations of one mechanical sign. Fig. 9, Ref. 12.

**Keywords:** solids, mechanical properties, ion crystal, shear deformation, effective elastic modulus

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**1.1.2.9. “Permittivity” of single-layer BN sheet.** /L. Chkhartishvili/. *Nano Studies*. – 2019. – #19. – pp. 291-292. – eng.; abs.: eng.

Nanocapacitors, which are prospective nanoelectronic devices useful, in particular, for electrical energy storage purposes, use nanosheet dielectrics. Effective permittivity, which is an important performance parameter for any nanocapacitor, for the monolayer sheet differs from that of the bulk layered crystal of the same material. Reconstruction characteristic of polar dielectric interface layers seems to be the mechanism affecting apparent permittivity of the corresponding capacitor structure. There is presented theoretical estimate of “permittivity” of the single-layer boron nitride hexagonal sheet. Fig. 2, Ref. 6.

**Keywords:** nanocapacitors, nanoelectronic devices, permittivity, boron nitride, hexagonal sheet

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**1.1.2.10. Spectrum of radiation of a bunch of positrons channeled in densely packed nanotubes.** /K. Gevorgyan, L. Gevorgian/. Proceedings of NAS RA. Physics. – 2019. – v. 54. – #2. – pp. 172-184. – rus.; abs.: rus., arm., eng.

The problem of the radiation of a relativistic bunch of positrons channeled in densely packed nanotubes was solved. A model parabolic potential was used for the average nanotube field. The channeled positrons oscillate with the same frequency, but with different amplitudes equal to the distance from the point of entry of the positron in the nanotube to its axis. The polarization of the nanotube environment leads to the appearance of a lower energy threshold for the formation of radiation. The boundaries of the frequency interval of radiation also depend on the amplitude of the oscillating positron. For the first time an analytical expression for the spectrum of the total radiation is obtained in the dipole approximation. At a zero angle, both hard (gamma) and soft (X-ray) photons are generated. Directed photon beams have important practical applications. Fig. 1, Tab. 1, Ref. 24.

**Keywords:** radiation spectrum, positrons, nanotubes, parabolic potential, dipole approximation

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**1.1.2.11. Determination of refractive index and thickness of nanosized amorphous carbon films via visible range reflectance spectra.** /G. Dabaghyan, L. Matevosyan, K. Avjyan/. Proceedings of NAS RA. Physics. – 2019. – v. 54. – #2. – pp. 249-252. – rus.; abs.: eng.

The values of thickness and refractive index ( $1.92 < n_f < 2.19$ ) of amorphous nanosized carbon films obtained on a crystalline silicon substrate by pulsed laser deposition were experimentally determined via an analysis of visible range reflection spectra. Obtained films can be used as single-layer anti-reflective coatings for semiconductors Si and GaAs. Fig. 1, Tab. 1, Ref. 9.

**Keywords:** refractive index, nanosized amorphous carbon, reflectance spectra, anti-reflective coatings

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**1.1.2.12. Interband Absorption and Photoluminescence in Nanospherical InP/InAs/InP Core/Shell/Shell Heterostructure.** /V. Harutyunyan, M. Mkrtchyan, E. Kazaryan, D. Hayrapetyan/. Proceedings of NAS RA. Physics. – 2019. – v. 54. – #1. – pp. 44-60. – rus.; abs.: rus., arm., eng.

Single-particle states of charge carriers in a nanospherical InP/InAs/InP heterostructure are theoretically considered in the isotropic effective mass approximation and in the regime of strong size quantization. Results of numerical calculations of the energy levels of charge carriers at different thicknesses of the quantizing InAs layer of the indicated heterophase structure are presented. It is shown that it is possible to achieve the desired value and position of the size quantization levels of charge carriers in the layer by appropriate choice of the layer thickness. Interband optical transitions in the InAs layer are also considered. Values of the effective broadening of the band gap of the InAs layer as a function of the layer thickness are calculated. It is shown by numerical calculations that the absorption has a resonant character and that diagonal transitions dominate in the spectrum of the interband absorption. Values of threshold frequencies and absorption curves for several diagonal transitions involving both light and heavy holes are given. The photoluminescence spectra in the spherical InP/InAs/InP nanoheterostructure were also constructed for various temperatures close to room temperature. Fig. 4, Tab. 9, Ref. 45.

**Keywords:** interband absorption, nanospherical InP heterostructure, InAs layer, band gap

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**1.1.2.13. Selective reflection of laser radiation from ultrathin layers of cesium atomic vapors confined in a nanocell.** /A.D. Sargsyan, A.S. Sarkisyan, D. Sarkisyan/. *Proceedings of NAS RA. Physics.* – 2018. – v. 53. – #4. – pp. 402-416. – rus.; abs.: rus., eng.

The effect of van der Waals interaction of cesium atoms with sapphire windows of a nanocell was experimentally studied using the selective reflection process. The distance between the windows (thickness  $L$ ) varied in the range 50-2000 nm and the nanocell was filled with vapors of cesium atoms. The  $C_3$  coefficient of van der Waals interaction for Cs atoms and ( $6S_{1/2} < 6P_{1/2}$  transition) the sapphire window of the nanocell is measured. It is shown that using a selective reflection spectrum it is possible to determine magnetic fields with a spatial resolution of 70 nm and, consequently, both homogeneous and highly gradient magnetic fields can be measured. Fig. 8, Ref. 24.

**Keywords:** laser radiation, ultrathin layers, nanocell, Cs atoms, selective reflection, the effect of van der Waals

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**1.1.2.14. Physico-mechanical and tribological properties of nanocomposites and their vulcanizates on the basis of molybdenum disulphide and ethylene-propylene block copolymer.** /N. Kakhramanov, G. Gasimova, S. Pesetskiy, A. Quliyev, E. Dadasheva, A. Qasanova/. *Azerbaijan Chemical Journal*. – 2019. – #1. – pp. 39-45. – eng.; abs.: rus., az., eng.

The effect of the concentration and size of molybdenum disulphide fine particles on the breaking stress ultimate tensile stress, elongation at break, melt flow index and wear resistance of composite materials based on ethylene-propylene block copolymer and molybdenum disulphide is considered. The possibility of a significant improvement in the properties of nanocomposites by carrying out the crosslinking reaction in a dynamic mode is shown. Nanocomposites patterns of transition from solid to viscous state are investigated by thermomechanical analysis. The optimal concentrations of the reacting components have been established, at which the highest physicomechanical properties of nanocomposites are achieved. Fig. 3, Tab. 2, Ref. 10.

**Keywords:** block copolymer, molybdenum sulphide, thermomechanics, nanocomposites, breaking stress

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**1.1.2.15. Influence of fullerenes on dielectric and conductivity properties of smectic A liquid crystal with negative dielectric anisotropy.** /T. Ibragimov, A. Imamaliyev, G. Ganizade/. Azerbaijan Journal of Physics. – 2019. – v. 25. – #1. – pp. 31-34. – eng.; abs.: eng.

Influence of fullerenes on dielectric and conductivity properties of smectic A liquid crystal is investigated. It is shown that the transverse component of the real part of dielectric permittivity increases at the additive of fullerenes while the longitudinal component decreases. At this case, a maximum of dielectric absorption shifts to the high-frequency region. Conductivity increases at low frequencies and decreases at the high ones. Experimental results are explained on the base of the Maier - Meier theory for anisotropic liquids and also participation of fullerenes in ionic conductivity of liquid crystal. Fig. 4, Ref. 13.

**Keywords:** liquid crystal, smectic A, fullerenes, dielectric permittivity

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**1.1.2.16. Structural peculiarities and dielectric properties of high-density polyethylene films containing InP and Ge particles.** /S. Rzayeva, Sh. Rashidova, T. Ismailov/. Azerbaijan Journal of Physics. –2019. – v. 25. – #1. – pp. 39-44. – eng.; abs.: eng.

High density polyethylene (HDPE) films of various thickness (100, 200  $\mu\text{m}$ ) and content (2-10 vol.%) of InP/Ge particles were obtained by hot pressing a homogeneous mixture of fillers with a polymer matrix under a pressure of 10 MPa and at a temperature  $T=413\text{K}$ . HDPE films with dispersed InP and Ge particles were characterized by a combination of X-ray fluorescence microscopy (XRFM), X-ray diffractometry (XRD) and infrared Fourier transform spectroscopy (FT-IR) methods. It is shown that the obtained samples are HDPE-based composites with nanostructured InP and Ge-particles with a size of coherent scattering regions (CSR) of 44.1 and 55.7 nm, respectively. By scanning the surface of the films with a spot of a beam with a diameter of 10  $\mu\text{m}$ , local concentrations of InP and Ge particles in the samples were determined. The dependence of the characteristic frequencies of FT-IR for HDPE at 719 and 730  $\text{cm}^{-1}$  on the concentration of the filler was established. The temperature (in the range of 290–440K) and frequency (range 25– $10^6$  Hz) dependences of the dielectric constant and the angle of the tangent of dielectric losses were measured. The dependence of the values of dielectric characteristics on the content of the filler in the composite is established. Fig. 5, Tab. 2, Ref. 15.

**Keywords:** InP, Ge, HDPE, X-ray fluorescence microscopy, X-ray diffractometry, infrared Fourier spectroscopy, dielectric properties

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**1.1.2.17. Photoluminescence properties of  $\text{Ni}_{1-x}\text{Zn}_x\text{Fe}_2\text{O}_4$  nanopowders.** /Sh. Ahmadova, T. Naghiyev, Sh. Aliyeva, A. Sadigova, T. Mehdiyev/. Azerbaijan Journal of Physics. –2019. – v. 25. – #2. – pp. 25-30. – eng.; abs.: eng.

The photoluminescence spectra of  $\text{Ni}_{1-x}\text{Zn}_x\text{Fe}_2\text{O}_4$  ferrite nanopowders with different Zn contents were studied. The experiments were carried out at 300K, spectral lines were used to excitation luminescence: Xe-lamp with the wavelength 280 nm, 290 nm, 300 nm, 325 nm, 350 nm, 375 nm, 388 nm, 400 nm, 425 nm, and also YAG Nd laser (532 nm). The obtained spectra were interpreted in the framework of the proposed model in [1] for  $\text{Fe}_3\text{O}_4$ , a structural analogue of  $\text{Ni}_{1-x}\text{Zn}_x\text{Fe}_2\text{O}_4$  ferrites. Fig. 4, Tab. 1, Ref. 15.

**Keywords:** ferrites, photoluminescence, nanopowders, sublattice

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**1.1.2.18. Dielectric relaxation in the colloid fullerenes - liquid crystal 5CB.** /G. Ganizade/. *Azerbaijan Journal of Physics*. – 2019. – v. 25. – #3. – pp. 3-6. – eng.; abs.: eng.

Influence of fullerenes C<sub>60</sub> on dielectric properties of liquid crystal 5CB (4'-Pentyl-4-biphenylcarbonitrile) is investigated. It is shown that at additive of fullerenes the components of the dielectric permittivity decrease, and the longitudinal component decreases by greater extent than its transverse component. The dielectric anisotropy also decreases. The dielectric absorption is shifted to low frequencies. The experimental results are explained by the Maier - Meier theory for anisotropic liquids. Fig. 4, Ref. 7.

**Keywords:** Liquid crystal; fullerenes; dielectric permittivity; phase transition

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**1.1.2.19. Optical and UV-VIS luminescence spectra of  $\text{Ni}_{1-x}\text{Zn}_x\text{Fe}_2\text{O}_4$  ferrite nanopowders.** /A. Sadigova, Sh. Aliyeva, Sh. Ahmadova, I. Yusibova, T. Naghiyev, T. Mehdiyev/. *Azerbaijan Journal of Physics.* – 2019. – v. 25. – #3. – pp. 34-43. – eng.; abs.: eng.

The optical and UV-VIS luminescent spectra of  $\text{Ni}_{1-x}\text{Zn}_x\text{Fe}_2\text{O}_4$  ferrite nanopowders with  $x = 0; 0,25; 0,4; 0,5; 0,6; 0,75; 1,0$  were investigated in  $4000\text{-}50\text{ cm}^{-1}$  and  $200\text{-}700\text{ nm}$  at room temperature. The features of the diffuse reflectance spectra of  $\text{Ni}_{1-x}\text{Zn}_x\text{Fe}_2\text{O}_4$  ferrites were analyzed by the Kramers-Kronig procedure. The agreement with the data of published studies of other authors allowed us to give a hypothetical interpretation of the results. Fig. 5, Tab. 2, Ref. 43.

**Keywords:** ferrites, nanopowders, IR spectra, hypothetical interpretation, Kramer-Kronig relations

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## 2. NANOCHEMISTRY

### 2.1. Inorganic Materials

**1.2.1.1. Nanochemical processes under conditions of geological repository: 1. Evolution of bentonite buffer.** /O. Lavrynenko, B. Shabalin, O. Pavlenko/. Nano Studies. – 2019. – #19. – pp. 223-238. – eng.; abs.: eng.

In the review, an analysis of the bentonite buffer evolution under the geological repository conditions of a high-level waste and spent nuclear fuel was carried out. The analysis of the results of modern laboratory, field and model studies of the evolutionary changes in clay affecting the stability of the buffer and the safety of the storage has been carried out. A number of aspects of the bentonite transformation are highlighted: low-temperature changes taking into account potential cementing, colloid-chemical changes during the bentonite interaction with water, the effect of swelling pressure is shown. The analysis of the processes at the phase-interfaces cement-bentonite and iron(steel)-bentonite was carried out. The effect of mechanical shifts/displacements of the host rocks and erosion of bentonite on the mass redistribution under storage conditions was shown there. Ref. 77.

**Keywords:** nanochemical processes, spent nuclear fuel

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### 1.2.1.2. Nanochemical processes under conditions of geological repository: 2. Steel-bentonite interface.

/O. Lavrynenko, B. Shabalin, O. Pavlenko/. Nano Studies. – 2019. – #19. – pp. 239-258. – eng.; abs.: eng.

In the second part of the review, a description of the processes proceeding on the steel-bentonite interface is given. The changes that the unsaturated groundwater undergoes a buffer upon contact with the surface of the steel container are considered. The results of modeling the corrosion process under conditions of geological storage are presented, and the contribution of the anionic component and microorganisms is highlighted. The main provisions that are taken into account in conducting geochemical modeling of corrosion processes in the conditions of geological storage of radioactive waste are presented. Ref. 85.

**Keywords:** steel-bentonite interface, unsaturated groundwater, buffer, geological repository, radioactive waste

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**1.2.1.3. Regio-controlled synthesis of double condensed oligo-, poly- and cyclo-phosphates, their characterization and possible solid-state applications.** /M. Avaliani, E. Shapakidze, N. Barnovi, D. Dzanashvili, G. Todradze, V. Kveselava, N. Gongadze/. *Nano Studies*. – 2019. – #19. – pp. 273-284. – eng.; abs.: eng.

The importance of the efficient and resource-saving technologies for synthesis and applications of new inorganic polymers - condensed compounds are out of any doubt which explains the relevance of authors' works thanks to original technological methods and experience that been cultivated over many years. Multilateral spheres of application of condensed phosphates are very diverse: ion-exchange materials, nanomaterials, efficient applying fertilizers, detergents, cement substances, catalytic agents, raw materials for phosphates glasses, thermo-resistant substances, and also as food additive composites. Besides, the phosphate's binding agents, phosphate-binders and laser materials are supplanted/replaced by biomaterials, on the base of polyphosphates and hydroxyapatite. Present work reviews information about numerous crystals and/or powder of inorganic polymeric compounds, concretely, diverse new groups of condensed phosphates, region-controlled synthesized by the authors during investigations of the systems  $M^I_2O-M^{III}_2O_3-P_2O_5-H_2O$  at 400-850 K (where  $M^I$  are various monovalent metals, including Ag, and  $M^{III}$  - diverse trivalent metals). Numerous, specifically 85, new, formerly unknown, double condensed phosphates - so-called inorganic polymers have been obtained. The possibilities of their application are investigated. For example, synthesized cyclooctaphosphate  $K_2Ga_2P_8O_{24}$  is studied for the catalytic activity. The results showed that it has unique properties as an inorganic polymer and can be used as a best catalyst during organic synthesis reactions, specifically, for the preparation of low molecular weight dienic oléfines. Accordingly to the experiments we established that synthesised acidic triphosphates of gallium and/or indium  $M^{III}H_2P_3O_{10} \cdot (1-2)H_2O$  are the best ion-exchange materials. Tab. 1, Fig. 5, Ref. 38.

**Keywords:** regio-controlled synthesis, resource-saving technologies, polymeric compositions, biomaterials, catalytic activity

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**1.2.1.4. Photolysis of the phenolic solution in the presence of  $\text{TiO}_2$  nanoparticles.** /E. Gadirova, I. Hasanova, G. Aliyeva, G. Eyvazova, M. Aghayev, Z. Gakhramanova, A. Aliyev, H. Mahmudov, M. Akhundova, F. Muradova/. *Azerbaijan Chemical Journal*. – 2019. – #2. – pp. 52-57. – eng.; abs.: rus., az., eng. <https://doi.org/10.32737/0005-2531-2019-2-52-57>

$\text{TiO}_2$  nanoparticles have been prepared using sol-gel method from titanium(IV), isopropoxide, isopropyl alcohol, ammonia hydroxide as precursors at mild condition without any post heat treatment for crystallization. The nanocrystalline  $\text{TiO}_2$  powders were composed of rutile form  $\text{TiO}_2$  by X-ray diffraction. The size of nanoparticles was examined by transmission electron microscopy and is about  $10^{-15}$  nm, and the Brunauer-Emmett-Teller specific surface area of the rutile nanopowder makes up 159.6  $\text{m}^2/\text{g}$ . Photochemical degradation of phenol solution under ultraviolet irradiation of the synthesized  $\text{TiO}_2$  nanoparticles has been carried out. Fig. 4, Ref. 19.

**Keywords:** nano $\text{TiO}_2$ , phenol, photocatalytic process, X-ray diffraction, transmission electron microscopy

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**1.2.1.5. Synthesis and physico-chemical study of platinum nanocomposite on mesoporous carbon nitride.** /V. Akhmedov, N. Melnikova, A. Babayeva, G. Nurullayev, Z. Aliyeva, D. Tagiyev/. *Azerbaijan Chemical Journal*. – 2019. – #3. – pp. 6-14. – eng.; abs.: rus., az., eng.

New platinum nanocomposites were synthesized using mesoporous carbon nitride as a stabilizing matrix and carrier for nanoparticles by the method of reduction of H<sub>2</sub>PtCl<sub>6</sub>·6H<sub>2</sub>O by methanol–water mixture. The textural, morphological, optical properties, structural and phase compositions of composites with different contents of loaded platinum particles were studied. The obtained composites have prospects for use as effective heterogeneous catalysts in chemical and photo-, electrochemical processes. Fig. 7, Tab. 1, Ref. 38.

**Keywords:** mesoporous carbon nitride, nanocomposite, platinum, physicochemical methods of analysis, heterogeneous catalysis

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**1.2.1.6. The process of Ostwald maturation on TlGaTe<sub>2</sub> crystal surface.** /K. Khalilova, N. Abdullayev, K. Kagramanov/. *Azerbaijan Journal of Physics.* –2019. – v. 25. – #1. – pp. 18-20. – eng.; abs.: eng.

It is shown that nano-island crystallization on TlGaTe<sub>2</sub> crystal surface is accompanied by their coalescence with process transition into Ostwald maturation. The analysis of conditions of Ostwald maturation (OM) stage beginning is carried out in the work. The growth mechanism on isotropic substrate on principle



doesn't differ from the one on crystal substrate. The process of condensate formation is divided on following parts: germformation, growth and coalescence of germs, channel formation. Fig. 5, Ref. 3.

**Keywords:** coalescence, maturation process, fluctuation, Ostwald maturation

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## 2.2. Organic Materials

**1.2.2.1. Removal of Fe(III) from aqueous solution by bio adsorption.** /M. Azadi, Y. Mirzaie, Z. Shams Ghahfarokhi, A. Ebrahimitalab, A. Teimouri/. Nano Studies. – 2019. – #19. – pp. 131-144. – eng.; abs.: eng. In the present study, chitosan (CS) was modified by nano-diopside (nDP) and nano-hydroxyapatite (nHAp) using the facile freeze-drying method. The prepared biodegradable nano-composite displays high efficiency in adsorption of Fe(III) ion in aqueous solution. The chemical and morphological structures of nano-composite were investigated by scanning electron microscopy (SEM), thermogravimetric analysis (TGA), X-ray diffraction (XRD), and Fourier-transform infrared spectroscopy (FT-IR). Moreover, effects of pH, contact time, adsorbent concentration, and temperature on the adsorption process were studied. The best adsorption efficiency (27.7mg/g) was obtained with 0.01g of CS/nDP/nHAp, at the pH of 7 and with the contact time of 30 min at 37°C. Tab. 1, Fig. 9, Ref. 47.

**Keywords:** nano-diopside (nDP), chitosan (CS), biodegradable nanocomposite, scanning electron microscopy (SEM), Fourier – transform infrared spectroscopy (FT-IT)

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**1.2.2.2. Effect of organic matter on hexavalent chromium reduction by nano zero valent iron in soil. /G. Allahverdiyeva/. Azerbaijan Chemical Journal. – 2019. – #2. – pp. 11-14. – eng.; abs.: rus., az., eng. <https://doi.org/10.32737/0005-2531-2019-2-11-14>**

The experimental data are presented on lowering concentration of chrome(VI) ions in soil (with a purpose of rendering it harmless) by nanoparticles of iron in the presence of high concentration of an organic compound (saccharase) as a reducing agent. The reiterated repetition experiments has proved an effectiveness of synthesized before iron nanoparticles. The basic parameters of an effective reduction of Cr(VI) by nanoparticles of iron have been found out. They are as follows: the time of reduction (2 h) and concentration of organic substances (35.71 g/kg of soil). It has been established that a rise in reduction duration above 2 h lowers its effectiveness. The cause of this, revealed by us, consists in that a high concentration of the organic compound provides for inhibiting of Cr(VI). It occurs on account of 1) adsorption of substance on a surface of iron nanoparticles and as a result the decrease in their active surface, 2) interaction of the organic compound with the products of the reduction reaction, 3) dissolution of saccharase in liquid phase. As result of investigation the necessity of determining the significance of high concentration of the organic substance for an effective reduction of Cr(VI) in soil is exposed. At present the work in this direction is being continued. Fig. 1, Tab. 1, Ref. 13.

**Keywords:** Fe<sup>0</sup> nanoparticles, organic matter, Cr(VI) reduction

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### 3. NANOBIOLOGY

#### 3.1. Uptake

**1.3.1.1. Change of biomass of cyanobacteria *Spirulina platensis* in nutrient medium Zarrouk at introducing of known amount of chemical elements: Cr, Se, Zn, Ni, Cu, Ag, Cd, and Hg, separately.** /N. Kuchava/. Nano Studies. – 2019. – #19. – pp. 263-272. – geo.; abs.: geo.

The problem of the change of biomass of one of the biotechnologically interesting blue-green cyanobacteria *Spirulina platensis* has been studied when the preliminarily determined amount of chemical elements such as chromium (Cr), selenium (Se), zinc (Zn), nickel (Ni), copper (Cu), silver (Ag), cadmium (Cd), and mercury (Hg) were introduced separately, during the initial stage of the experiment. The method of atomic absorption spectrometry was used. Tab. 8, Ref. 13.

**Keywords:** biomass, cyanobacteria, nutrient medium, chemical elements atomic absorption microscopy

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**1.3.1.2. Influence of Mg on uptake of Zn, Cu, and Cr by *Arthrobacter globiformis* 151B.** /A. Rcheulishvili, L. Tugushi, E. Ginturi, M. Osepashvili, O. Rcheulishvili, M. Gurielidze/. Nano Studies. – 2019. – #19. – pp. 293-298. – geo.; abs.: geo.

To characterize metals joint action on highly resistant gram-positive aerobic bacteria, we have studied the influence of Mg ions on the accumulation capacity of Zn, Cu, and Cr ions by *Arthrobacter globiformis* 151B, which is promising candidate for good bioremediation. Bacterial cells were incubated at 26°C during different periods of time: 16, 24, 48, 96, and 144 h. For the experiment, the concentration of magnesium in the growth medium (TSB Broth) made up 1600 µg/ml. After that, they were harvested and tested on the content of research elements (zinc, copper and chromium) using atomic absorption spectroscopy. According to the research data, high concentration of magnesium can increase the accumulation capacity of zinc, copper and chromium over time. Fig. 3, Ref. 14.

**Keywords:** metals joint action, highly resistant gram-positive bacteria, accumulation capacity, bacterial cells

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## 4. NANOTECHNOLOGY

### 4.1. Materials and Structures

**1.4.1.1. Method for manufacturing nanocrystalline systems from liquid charge.** /A. Mikeladze, O. Tsagareishvili, L. Chkhartishvili, R. Chedia, R. Tsiskarishvili/. Nano Studies. – 2019. – #19. – pp. 15-36. – rus.; abs.: rus.

A technology has been developed for the production of nanocrystalline systems of a wide range by spraying solutions of salts of the corresponding components in liquid organic compounds into a reactor with a reducing or carbide-forming medium. After pyrolysis, selective reduction processes and carbidization, powders are obtained, each particle of which can consist of nanocrystalline components (with crystallites sizes of 10-80 nm depending of initial solution) - metals, oxides, carbides, and quasibinary ceramics. In this way were obtained: (1) dispersion-strengthened transition metals and alloys with increased strength while retaining plastic properties; (2) titanium, tungsten, and boron carbides nanocrystalline cermets with high hardness and enhanced strength; and (3) nanocrystalline ceramics based on boron carbide/titanium diboride composition  $B_4C-TiB_2$  with high hardness and increased impact toughness. Fig. 16, Ref. 10.

**Keywords:** nanocrystalline systems, spraying solution, carbide-forming medium, liquid charge

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**1.4.1.2. Electrodeposition of tungsten nanostructured galvanic coatings from tungstate containing melts.** /V. Malyshev, A. Gab, D. Bruskova, T. Dmytrenko, M. Gaune-Escard/. Nano Studies. – 2019. – #19. – pp. 77-86. – eng.; abs.: eng.

Electroreduction of dimer complexes of tungsten in metaphosphate-containing melts is studied using methods of voltammetry. Deposition of tungsten and tungsten-molybdenum coatings from oxyhalide and

oxide melts and the influence of the electrolysis parameters on the properties of the deposits are investigated. Tab. 1, Fig. 7, Ref. 13.

**Keywords:** electroredemption, tungsten, nanostructured galvanic coating, electrolysis, deposits

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### 1.4.1.3. Synthesis of nanostructured coatings molybdenum (tungsten) - nickel (cobalt) in tungstate melts.

/V. Malyshev, D. Shakhnin, A. Gab, T. Lukashenko, O. Dmytrenko/. *Nano Studies*. – 2019. – #19. – pp. 87-96. – eng.; abs.: eng.

The electrochemical behavior of nickel and cobalt in a tungstate melt and the effect of the electrolysis conditions on the composition and structure of the deposits of the nickel (cobalt)-molybdenum (tungsten) alloys and intermetallic compounds in oxide tungstate melts are studied. As the molybdenum (tungsten) concentration in the melt increases or the nickel (cobalt) concentration decreases, the phase composition of the cathodic deposits changes from nickel through nickel (cobalt) - molybdenum (tungsten) alloys and intermetallics of different compositions to pure molybdenum (tungsten). Tab. 3, Fig. 7, Ref. 12.

**Keywords:** tungstate melt, molybdenum (tungsten) concentration, alloys, intermetallics, oxide tungsten melts

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**1.4.1.4. Obtaining of new polytetrafluoroethylene based tribotechnical composite materials and studying their properties.** /E. Kutelia, D. Gventsadze, L. Rurua/. Nano Studies. – 2019. – #19. – pp. 115-120. – geo.; abs.: geo.

Aim of the research was the obtaining the new polytetrafluoroethylene (PTFE) based composite materials by using natural mineral - chalcopryrite ( $\text{CuFeS}_2$ ) - microparticles and studying their properties. On PTFE base, there were made polymeric composites filled with 2.5, 5, and 10 wt. % chalcopryrite powder. The wear intensity of these composites was determined at different friction speeds and results were compared with the characteristics of the best tribotechnical material - superfluvis. In case of further improving their tribological properties, we will get quite cheap and effective tribotechnical material. Tab. 1, Fig. 3, Ref. 4.

**Keywords:** polytetrafluoroethylene (PTFE), tribotechnical composite, superfluvis, tribological properties

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**1.4.1.5. Features of synthesis of gold nanoparticles using reagents of green chemistry.** /T. Pavliashvili, E. Gelagutashvili, A. Tutunjan, G. Tsertsvadze/. Nano Studies. – 2019. – #19. – pp. 121-124. – eng.; abs.: eng. Synthesis of gold nanoparticles from chloroauric acid using sodium citrate and tannin was studied. To prepare solutions, distilled water was used. The sodium citrate - tannin solution was prepared at room temperature, filtered and added with constant stirring to a 0.01% solution of  $\text{HAuCl}_4$ . The optical absorption spectra of nanoparticles had an absorption maximum of 553 nm. The studies conducted with transmission electron microscopy showed that spheroidal and ellipsoid nanoparticles, as well as nano-triangles, were formed. The size of the formed gold nanoparticles turned out to be mainly in the range of 15-35 nm. Treatment of the solution in a microwave oven caused a decrease in the size of the nanoparticles and a shift in the optical absorption maximum towards the short waves (537 nm), apparently due to the further process of fragmentation of gold nanoparticles in the solution. Histograms were constructed for the distribution of gold nanoparticles in size before and after microwave exposure. Fig. 3, Ref. 5.

**Keywords:** gold nanoparticles, synthesis, green chemistry, histograms, solutions, microwave exposure

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**1.4.1.6. Effect of thermal treatment on hot-pressed isotopically modified boron carbide  $^{10}\text{B}_4\text{C}$ .** /Z. Mestvirishvili, Sh. Zurabishvili, T. Mestvirishvili, Kh. Bluashvili, A. Sitchinava, N. Jalabadze/. *Nano Studies*. – 2019. – #19. – pp. 145-152. – rus.; abs.: rus.

Ceramic samples of  $^{10}\text{B}_4\text{C}$  were obtained by hot pressing at temperature of 2100°C and pressure of 30 MPa. They were thermally treated in vacuum at 1800°C. Optical and scanning microscopic studies were carried out. The physical-mechanical properties of obtained ceramics were studied. The effect of thermal treatment on their machinability, fracture toughness, hardness, elastic modulus, as well as on the mechanical strength has been determined. Tab. 1, Fig. 5, Ref. 19.

**Keywords:** thermal treatment, boron carbide, ceramic samples, microscopic studies, fracture toughness, elastic modules

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**1.4.1.7. A study of the condensed copper-containing nanomaterials.** /D. Jishiashvili, Z. Shiolashvili, N. Makhatadze, A. Jishiashvili, A. Chirakadze, V. Gobronidze/. *Nano Studies*. – 2019. – #19. – pp. 285-290. – eng.; abs.: eng.

The development of new technologies for the vapor phase growth of copper-based materials is an important issue, which enables the formation of nano-sized structures. In this work, we have demonstrated that volatile Cu-containing molecules can be formed directly in the reaction zone by annealing Cu or CuO solid sources in the gaseous medium comprising ammonium chloride and hydrazine. We suggest that at the first stage of synthesis the CuCl volatile molecules were formed, followed by a Cu mass transfer to the Si substrate located above the source. In the case of Cu source, after reaching the Si substrate the CuCl molecules were reduced by hydrogen forming crystalline Cu microstructures. When CuO source was annealed at 700°C, the copper oxide nanostructures were produced on Si due to the presence of excess oxygen, which was released from CuO source. Fig. 4, Ref. 15.

**Keywords:** copper-based nanomaterials, nano-sized structures, copper-oxide nanostructures, excess oxygen

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**1.4.1.8. Metal-containing nanoparticles in a maleinized polyethylene matrix as nanofillers for polypropylene.** /N. Kurbanova, Z. Huseynova, N. Ishenko, A. Aliyev, T. Guliyeva, S. Ragimova, S. Rzaeva/. *Azerbaijan Chemical Journal*. – 2019. – #1. – pp. 54-58. – eng.; abs.: rus., az., eng.

The effect of additives of metal-containing nanofillers including nanoparticles of zinc oxide stabilized on a polymer matrix of maleinized polyethylene on the properties of nanocomposites based on isotactic polypropylene by methods X-ray phase and thermogravimetric analyses was studied. The improvement of

the strength and rheological indexes, as well as the thermooxidative stability of the nanocomposites obtained was revealed. Fig. 2, Tab. 2, Ref. 11.

**Keywords:** isotactic polypropylene, metal-containing nanofillers, maleinized polyethylene matrix, physical and mechanical properties

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**1.4.1.9. SmS thin films with nanosize surface architecture** /Y. Aliyeva/. *Azerbaijan Journal of Physics.* –2019. – v. 25. – #3. – pp. 47-51 – eng.; abs.: eng.

Samarium sulfide thin films with thickness in the range from 40 to 100 nm were deposited on vacuum annealed sapphire plates that received ion beam treatment after annealing to reduce surface roughness. The deposited thin films were then subjected to vacuum annealing and ion beam treatment again and films surfaces good enough to use scribing to create nanosize surface elements were obtained. Diffraction grating was then prepared with the aid of a diamond coated cantilever and examined using electric force (EF) and magnetic force (MF) modes of atomic force microscope (AFM). The prepared grating was shown to have semiconducting channels between the metallic grooves separated from one another by 100 nm distance. The disclosed distinct properties of the grating are discussed in terms of variable valence of Sm ions. It is figured out that SmS thin films are very promising as materials to scribe on and obtain desirable surface architecture. Fig. 4, Ref. 10.

**Keywords:** Atomic Force Microscopy, SmS polycrystalline film, nanoscale structures, diffraction grating, Magnetic Force Microscopy, Electric Force Microscopy

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## 5. NANOENGINEERING

### 5.1. Devices and Sensors

**1.5.1.1. Highly photosensitive and radiant energy-saving molecular switches.** /L. Devadze, J. Maisuradze, G. Petriashvili, Ts. Zurabishvili, N. Sepashvili, Sh. Akhobadze/. Nano Studies. – 2019. – #19. – pp. 97-102. – eng.; abs.: eng.

The work is based on an increase of effective photosensitivity of some spiropyrans (spirochromens) in a liquid-crystal matrix, which was discovered and studied by authors previously. The merocyanine molecules formed as a result of photoinduction with the ultraviolet (UV) light are structured as nano-particles, the micelles. The originated micelles deplete the base solution off merocyanine molecules and spiropyran molecules start to transform into the merocyanine molecules to restore the thermodynamic equilibrium. The merocyanine molecules formed photochemically are added by the molecules formed to restore thermodynamic equilibrium. The coloration of the system continues at the expense of the internal energy without consuming the radiant energy. By doping the composition in the polymer by using the innovative method developed by us, we obtained highly photosensitive and energy-saving polymer films with the ability of photo-regulation of their optical properties. Such an economy of the electrical power is quite significant when recording and reading large information massifs. Therefore, we consider it purposeful to use such polymer films as a photosensitive system in modern computers recording and processing the data, molecular machines, etc. Fig. 6, Ref. 13.

**Keywords:** molecular switches, photosensitivity, ultraviolet light, thermodynamic equilibrium, molecular machines

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**1.5.1.2. Thin-film Sol transistor as base of generation of smart nanosensors of external influences with improved properties.** /A. Leonov, V. Mordkovich, M. Pavlyuk/. Nano Studies. – 2019. – #19. – pp. 103-110. – eng.; abs.: eng.

It was demonstrated that magnetosensitive Sol (silicon-on-insulator) thin film transistors (TFT) with built in channel, double gates MOSOM (metal-oxide-Si-oxide-metal) control system, and opposite ohmic contacts to lateral channel sides (so called field effect Hall sensor - FEHS) provide the creation of smart magnetic nanoelectronic sensors with radically improved characteristics in comparison with conventional Si Hall elements. In particular FEHS improved magnetosensitivity operating temperature, radiation immunity, and power consumption. Such advantages are due of FEHS construction and Sol-technology for its manufacture. It was also demonstrated that SOI MOSOM TFT with built-in channel may be the attractive sensitive

elements for sensors of other external influences such as temperature, radiation, atmospheric gases composition, etc. Fig. 6, Ref. 18.

**Keywords:** Sol transistor, smart nanosensors, thin film transistors (TFT), Hall effect sensor (HES), radiation, gases, external influences

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**1.5.1.3. Single channel laser rangefinder with aspheric concentrating mirror.** /T. Khachidze, D. Zardiashvili, G. Mchedlishvili/. Nano Studies. – 2019. – #19. – pp. 299-302. – geo.; abs.: geo.

The article refers to laser rangefinder (LRF) design issues. Single channel LRF with punctured aspheric mirror is proposed, which transfers laser beam to objective lens and transmits focused and reflected light to photodiode with minimal losses at the same time. Apart from that aspheric surface focuses light unlike flat one and makes it possible to receive laser beam spot of smaller size on photodiode. By changing the focal length of the mirror, it becomes possible to vary distance to photodiode without changing the focal length of the objective lens. Fig. 2, Ref. 4.

**Keywords:** laser rangefinder (LRF), design, punctured asphernic mirrior, focal length of the miror, objective lens

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**1.5.1.4. Study of hydrogen peroxide vapors sensors made on the base of carbon nanotubes coated with tin oxide nanoparticles.** /Z. Adamyan, A. Sayunts, E. Khachaturyan, V. Arakelyan, V. Aroutiounian, B. Joost/. Proceedings of NAS RA. Physics. – 2019. – v. 54. – #1. – pp. 75-84. – rus.; abs.: rus., arm., eng.

In this work, we present the results of studies of the nanocomposite MWCNTs/SnO<sub>2</sub> hydrogen peroxide vapor sensors. The technology of manufacturing of these sensors has been developed. 100°C optimal operating temperature of the studied sensors has been found as a result of the measurements of the temperature characteristics. The response and recovery curves of the sensors were investigated in the presence of different concentrations of hydrogen peroxide vapor in the atmosphere. Sufficiently high response is observed when low concentrations of the target gas present in the air. The linear dependence of the response of the sensor on the concentration of hydrogen peroxide vapor is observed in a double logarithmic scale in a certain concentration range. The minimal registered gas concentration is 1 ppm or less. Fig. 5, Tab. 2, Ref. 23.

**Keywords:** hydrogen peroxide vapor sensor, nanocomposites, temperature characteristics, gas concentration

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**1.5.1.5. Concept of an optical magnetometer based on the spectroscopy of alkali vapors confined in nanometric-thick cells.** /E. Klinger/. Proceedings of NAS RA. Physics. – 2018. – v. 53. – #4. – pp. 417-431. – rus.; abs.: rus., eng.

In this article, we present the concept of an optical scalar magnetometer based on the spectroscopy of hot alkali vapors confined in nanometric-thick cells. We present an appropriate theoretical model to describe the interaction of linearly and circularly polarized light with atomic alkali vapors confined in extremely thin cells where a longitudinal magnetic field is applied. This model can be used to perform consecutive fittings of experimental spectra recorded by derivative selective reflection method, in order to measure the value of magnetic field. We illustrate the model with various calculated spectra for natural Rb vapor, while equivalent results hold for other alkalis (Na, K, and Cs). We analyze the feasibility of the concept for different cases depending on light polarization and cell thickness, and discuss possible limitations of the technique. Fig. 5, Ref. 17.

**Keywords:** optical magnetometer, spectroscopy, alkali vapors, nanometric-thick cells, feasibility, Rb vapor, light polarization, cell thickness

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**1.5.1.6. Plasmonic Nanoparticles Arrangements for Biosensing (Proceedings of the Int. Conference on “Microwave and THz Technologies and Wireless comm.”).** /H. Parsamyan, T. Yezekyan, H. Haroyan/. Armenian Journal of Physics. – 2018. – v. 11. – #4. – pp. 241-245. – rus.; abs.: rus., arm., eng.

The localized surface plasmon resonance (LSPR) of gold and silver spherical and cubic nanoparticles (NP), as well as NP dimers is studied. We use numerical simulations based on finite element method to derive extinction cross sections (ECS) and LSPR wavelengths of the investigated structures. Study of the dependence of the LSPR of the cubic NPs on the different values of chamfering radius shows the red shift of the resonant wavelength while decreasing the chamfering radius. For the silver nanocube the analysis

suggests three extinction peaks on  $\sim 333$  nm,  $\sim 364$  nm due to strong absorption and on  $\sim 400$  nm due to scattering, while for gold nanocube there is only one extinction peak on  $\sim 526$  nm. The diameter of the spheres and the sides of the cubes is 50 nm. According to the simulations the localized surface plasmon properties of the silver nanoparticles are much stronger and more diverse than that of corresponding gold nanoparticles. The study of nanocube and nanosphere dimers is carried out as well. Fig. 3, Ref. 10.

**Keywords:** surface plasmon, plasmonic nanoparticles, biosensing, finite element method.

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**1.5.1.7. Generation of Optical Radiation in Nanotube Undulators.** /K. Gevorgyan, L. Gevorgyan/. Armenian Journal of Physics. – 2018. – v. 11. – #3. – pp. 125-129. – eng.; abs.: eng.

The possibility to generate an sufficiently intense, monochromatic and directed radiation in the near ultraviolet range was investigated. Such radiation has important practical application in biology and medicine. It is shown that for a certain choice nanotube parameters channeled relativistic positrons in it the bunch will radiate as gamma photons and the "water window" photons also. Ref. 12.

**Keywords:** tunable radiation, channeling, nanotube undulator, positron bunch, medium polarization, water window

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## 6. NANOMEDICINE

### 6.1. Medical Physics

#### **1.6.1.1. Actual problems of boron-neutron-capture-therapy and prospects for its implementation in Georgia.** /D. Arutinovi/. Nano Studies. – 2019. – #19. – pp. 153-202. – geo.; abs.: geo.

On the one hand, the increase in mortality in the World due to tumors and, on the other hand, fast development of particles' accelerators allows us to take a fresh look at the issue of increasing the effectiveness of the use of various radiation therapies for providing high-tech care to oncological patients. At the same time, it should be taken into account that, according to modern ideas, the presence of a malignant tumor is so-called systemic disease and methods of treatment of standard-type tumors are different for disseminated and systemic diseases, as well as for locally distributed processes of similar diseases. Radiation therapy with this or that radiation (X- or gamma-rays, electrons, protons, neutrons, ions, etc.) acts directly on the tumor. Among the methods of clinical oncology, radiation therapy occupies one of the leading places. According to the World Health Organization, 70-75% of cancer patients need radiotherapy. To date, radiotherapy is the leading method of conservative treatment and for cancer patients both radical and palliative variants of such treatment are used. Every fifth patient can be recovered by radiotherapy. The advantages of radiotherapy include patients relatively tolerability to treatment, possibility of a sustainable cure of some tumors in the early stages while maintaining the function of the injured organ, etc. And with independent palliative therapy in inoperable cases, the use of radiation treatment is most effective among other medical interventions. Specifically, boron neutron capture therapy (BNCT) is a multidisciplinary task. For its realization, it is necessary to co-operate specialists of different profiles - doctors, biologists, physicists, chemists, and engineers. The priority areas of research are: development the new delivery agents of boron in order to increase the effectiveness of this therapy, reducing the risk of damaging of healthy cells, using the new neutron sources and improving the existing ones, dosimetry), resolving a number of applied problems of this therapy, and the implementation of obtained results in clinical practice. The implementation of such methods allows achieving high results of treatment if the provided radiation dose is satisfactorily tolerant for the normal tissues adjacent to the tumor. BNCT is practically a non-alternative method for treating patients with brain tumors such as, for example, multiform glioblastomas and anaplastic astrocytomas. BNCT essentially improves efficiency of recovery in combination with other modern treatment options. Successful clinical trials of treatment with BNCT of numerous liver metastases (which to this day remain practically incurable) have been started. Analysis of the materials of the International Scientific Conferences and Meetings on BNCT shows that this direction is being developed in about 30 scientific centers and more than 200 laboratories in the World. Range of applications of this therapy is expanding more and more, accelerating technique that forms a beam of epithermal neutrons is being improved, intensive synthesis and selection of those new drugs that have the ability to be accumulated in the tumor are continuing. Nuclear reactors, cyclotrons with neutron-forming targets, linear accelerators, isotopic sources, etc. are used as neutron sources. In the paper, the significant role that is assigned to radiation therapies, in general, in the fight against tumor diseases and, in particular, the contribution that BNCT can make in this fight, is analyzed. Briefly are characterized the available, including the latest, literature. The radiotherapy is characterized. The therapeutic effects of irradiation by heavy particle fluxes, in general, and neutrons, in particular, and also the basic parameters of the equipment necessary to achieve this goal are described. The methodology the actual treatment by the boron neutron capture therapy approach has been handed over, neutron sources with the necessary parameters are characterized as well, conditions for chemical compounds intended for use in BNCT and methods for measuring boron content in biological objects are described, and information is provided on modern international centers of the BNCT. There are presented the interviews with Georgian radiation therapy experts and, to the possible extent, summarizes and generalizes their responses. There are formulated recommendations for the implementation of the BNCT in Georgia developed by the author based on the analysis of information from the scientific literature and the results of the interviews with experts that he had conducted. These recommendations address all the main aspects of the problem such as: conditions for the operation of the equipment, composition and qualifications of the operating personnel, technical cooperation and communication with clinics and associations working in the

appropriate direction, implementation of procedures, preparation, provision of equipment resources, geographic factors, and other issues related, for example, to public relations, etc. In author's afterword and conclusions, the key factors that contribute to and impede the implementation of the BNCT in Georgia are sharpened. Tab. 3, Fig. 6, Ref. 16.

**Keywords:** boron neutron capture therapy (BNCT), non-alternative method, beam of epithermal neutrons, scientific literature, biological objects, recommendations

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**1.6.1.2. Influence of physical factors on blood outdraining volume.** /M. Chikhladze, M. Chikhladze, O. Ketiladze/. Nano Studies. – 2019. – #19. – pp. 259-262. – geo.; abs.: geo.

The paper deals with influence of blood pressure gradient and hemodynamic resistance on the blood outdraining volume. Based on physical statements, blood motion and mechanism of arising of pressure gradient are explained. Normal values of blood speed and of “excess” pressure are given for different bloodvessels. Fig. 1, Ref. 3.

**Keywords:** physical factors, blood outdraining volume, pressure gradient, normal valued blood vessels

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