ABSTRACT AND REFERENCES

APPLIED PHYSICS. MATERIALS SCIENCE

## FEATURES OF SCHEMATIC AND PHYSICAL AND TOPOLOGICAL DESIGN OF ANALOG INTEGRATED COMPARATORS (p. 4-15)

**Stepan Novosyadlyy**

In practice, devices, which form either voltage with opposite polarity at the output at almost equal absolute values or voltage with the same polarity are the most widely used. The first option is typical for using as a comparison circuit of operational amplifier (OP), and the second – in using specialized integrated circuits. In the second case, the output voltages of the comparator are consistent in magnitude and polarity with the signals, used in digital technology.

Based on the above, we can say that the input signal of the comparator is of the analog nature, and output – digital. Consequently, comparators often act as elements of communication between analog and digital devices, i.e. act as analog-digital converters (ADC).

Due to the fact that both analog and digital signals are used in modern telecommunication systems, we have both analog and digital comparators, respectively. Digital comparator differs from analog in that it is designed to compare two numbers that are given in the form of binary codes.

**Keywords**: operational amplifier, single-limit analog comparator and Schmitt trigger, C-MOS.

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## MODELING THE EFFECT OF INHOMOGENETIES ON SPECTRAL CHARACTERISTIC OF NARROW-BAND OPTICAL FILTERS (p. 15-20)

**Vasil Petsko, Alexander Mitsa**

Layered-inhomogeneous model of the refractive index profile, which includes primary and transition region is developed, the effect of the transition region with inhomogeneous distribution of the refractive index on the spectral characteristics of narrow-band filters depending on the angle and polarization is investigated in the paper. The basic dependencies of the change in parameters of transmission spectra of multilayer interference structures of narrow-band optical filters depending on the polarization and incidence angle in the presence of the transition region are given. The results obtained are important for determining the efficiency of using convergence or divergence of radiation fluxes in optical systems. The features of spectral characteristics of partially inhomogeneous films with different types of distribution of the refractive index at interfaces are defined. These features of spectral characteristics allow to extend the possibility to use films of non-crystalline materials in designing and manufacturing of narrow-band optical filters.

**Keywords**: characteristic matrix, spectral characteristics, transmission spectrum, refractive index inhomogeneties.

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## MULTIPLENESS DETERMINATION OF HYPOSCOPE IS AT THE TERMS OF PROVIDING OF THE SET EYESHOT (p. 20-24)

**Alexander Bilenko, Yuriy Belashov**

The features of the modern armed conflicts are required by the sniper fire mission by high-reliability and an operationability. For increase of the firing efficiency of the sniper rifle are equipped hyposcopes, the increase of multipleness of which positively influences on purpose hit of the probability but negatively affects the mean expected time on the fire job processing. There is certain correlation of angular sizes of target and corner eyeshots at which a fire task will be executed with most efficiency breech-sight. Consequently, development of method of determination of multipleness of hyposcope at the terms of providing of the set eyeshot at the fire job processing a sniper is actual tasks.

By the methods of optics dependence which links multipleness of hyposcope and distance to the purpose for certain eyeshot is got, which the developed method is on the basis of, that allows to determine the maximal value of multipleness of hyposcope at the terms of providing of eyeshot no less set.

The got method allows to determine the rational correlation of angular sizes of purpose and eyeshot hyposcope which will be instrumental in the increase of efficiency of the fire task processing a sniper. The developed method can be also used for development of recommendations on application of weapon with hyposcopes and during forming of requirements to technical descriptions of such weapon.

**Keywords**: sniper, hyposcope, multipleness, fire task, firin, effectiveness of fire.

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## RESEARCH OF DIELECTRIC POLARIZATION OF SOIL MASSES (p. 24-28)

**Liudmyla Trykoz, Oleg Gerasymenko**

To develop effective measures on preventing landslide processes it is necessary to investigate the driving forces and improve models of violations of local stability of slopes for cases when the shear forces are caused by the weight of the mass, as well as possible macroelectrokinetic phenomena in soils. The potential difference in soils can be caused not only by an external electric field, but also when filtering rainwater or groundwater on slopes - analogue of streaming potential, known in colloid chemistry. Potential difference can lead to known electrokinetic phenomena - electrophoretic movement of negatively charged soil particles towards excess positive charge (potential), herewith, repulsive forces, causing soil loosening occur. During the imposition of a constant electric field, all disperse systems are exposed to polarization by both the active and reactive (capacitive) component of the electrical conductivity. In the latter case, this is caused by the polarization of the electric double layer of soil particles. The results of theoretical and experimental studies of polarization phenomena in the soil mass, being dielectric by its electrical properties are given in the paper. It is shown that the internal polarization field is directly proportional to the external electric field intensity. Described theoretical concepts on the dielectric polarization of soils and the experimental data can be used as a basis for preventing hazardous processes such as landslides, slips and other adverse processes.

**Keywords**: soil mass, dielectric polarization, electric double layer, electric field intensity.

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## POSSIBILITY OF SUBSTITUTING UNSTEADY CONDITIONS OF THE HEAT SUPPLY BASED ON LOCALIZATION THEORY (p. 29-33)

**Viktor Prokopov**

The results of the mathematical modeling of the nonlinear, unsteady heat transfer process in a heterogeneously layered system with discontinuous pulse heating were given. On the basis of one of the localization theory principles, i.e., the principle of substituting the single-valuedness conditions, the possibilities of substituting unsteady conditions of the heat supply by their stationary counterparts were studied. The cases when the heat supply was performed either to the outer surface of the plate or by setting the internal energy sources, specially distributed through the plate thickness, were considered. It was shown that due to the presence of localization effects replacing the time dependence of the heat by more simple relations under certain conditions, specified in the paper, had insignificant effect on the temperature mode of the system outside the respective localization zones. It was also noted that the proposed substitution of the single-valuedness conditions allowed simplifying the mathematical model of the process and finding the solution.

**Keywords**: mathematical modeling, unsteady heat supply, phenomenon of localization, principle of substitution.

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## INTERACTION BETWEEN SMALL PARTICLES IN AN ELECTROLYTE SOLUTION (p. 34-38)

**Sergii Shostak, Nataliia Shkoda**

In studying ion-electrostatic interactions in systems of small particles in electrolyte solutions, the main task is to calculate the energy and forces of interaction that occur between the particles. This problem is closely related to the problem of finding the surface energy of double layers in the interaction of particles in such media. Starting with the works of B.V. Derjaguin, this problem is paid much attention, moreover, it is relevant up to the present time, especially when considering the interaction of small inorganic particles with biological cells or microorganisms. Interaction of diffuse double surface layers, appearing around the particles, is usually calculated based on the method of zones of B.V.Derjaguin. But using this approximation can lead to incorrect results.

The solution of the Debye-Huckel equations for a system of spherical particles with arbitrary radii and surface charges or potentials, located in the electrolyte was constructed in the paper. A general theoretical method for calculating the interaction of the particles in such systems was developed. Practically important two-particle case was considered in detail. From the general relations in the zero approximation, analytical formulas for finding the energy of interaction between two spherical particles with constant charges or potentials were obtained. Known relations of the Derjaguin-Landau-Verwey-Overbeek theory follow from the formulas in the limiting cases.

**Keywords**: Derjaguin-Landau-Verwey-Overbeek theory, Debye-Huckel equation, small particles, energy of interaction.

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## SYNTHESIS OF GOLD NANOPARTICLES FROM AQUEOUS SOLUTIONS OF CHLOROAURIC ACID WITH PLASMA-CHEMICAL METHOD (p. 39-44)

**Margarita Vorobyova, Alexander Pivovarov, Viktoriya Vorobyova, Liliya Frolova**

Plasma-induced non-equilibrium liquid chemistry is used to synthesize gold nanoparticles (AuNPs) without using any reducing or capping agents, since the development of new high technologies to obtain nanoscale inorganic compounds is currently relevant. The morphology and optical properties of the synthesized AuNPs are characterized by transmission electron microscopy (TEM) and ultraviolet–visible spectroscopy. The UV–vis spectroscopy revealed the formation of gold nanoparticles by exhibiting surface plasmon absorption maxima at 548 nm. Plasma processing parameters affect the particle shape and size and the rate of the AuNP synthesis process. Transmission electron micrograph (TEM) showed presence of spherical particles in the range of 7–60 nm size. Particles of different shapes (e.g. spherical, triangular,) are synthesized in aqueous solutions. Conclude that H2O2 plays the role of the reducing agent which converts AuCl ions to $Au_0$ atoms, leading to nucleation growth of the AuNPs.

**Keywords**: obtaining, sol, gold, solutions, tetrohloroaurat, nanoparticles, contact nonequilibrium low-temperature plasma, mechanism, action, hydrogen hydrogen.

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## MATERIALS SCIENCE AND FORECASTING APPROACH TO SELECTING A PRESSURED WATER REACTOR VESSEL (p. 45-51)

**Andrii Odeychuk**

Currently, more than thirty nuclear power plants (NPP) are designed in the world. In connection with the developing crisis in the global economy, during implementation of a specific NPP construction project, all other things being equal, the economic component appears. Major capital expenditures fall on the reactor vessel.

The paper proposes materials science-forecasting approach to selecting a pressurized water reactor vessel, which lies in forecasting the cost of the components that make up hull plates, represented in the form of time series and, based on them, determining the forecasted cost of the reactor vessel, performing the analysis, formulating conclusions and recommendations.

The information technology for forecasting time series with the risk assessment, which ensures the implementation of the proposed materials science-forecasting approach is developed. Information technology was software-implemented and tested on the example of solving the problem of substantiating the selection of pressurized water reactor vessel based on forecasting the cost of the major components of hull plates, represented in the form of time series for 2017–2022. Forecasting error is 12.94 %, which is by 12 % better than the traditional approach, forecasting risk is14.5 %.

It is shown that in selecting a new reactor plant for Ukraine for the forecast period, the pressurized water reactor vessel, made of steel A 533GR B 1989 is the most promising in terms of cost indexes.

**Keywords**: materials science-forecasting approach, reactor vessel, information technology, time series.

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## PECULIARITIES OF CORROSION DEGRADATION OF STEEL OF OIL PIPELINES (p. 52-55)

**Vasyl Luzhetskyy**

Both domestic and foreign scholars dealt with studying various aspects of corrosion degradation of steels of oil pipelines. At present, there are numerical-analytical methods for calculating stress intensity factors for cracks of various shapes in cylindrical bodies under loads, simulating the operational loads on the oil pipeline, as well as methods for assessing the operational degradation of materials of oil pipelines.

However, it is necessary to take into account the fact that degradation of the material under the long-term action of the operational factors is a multi-stage process, and the effect of each stage ultimately determines the durability of the tube element in predetermined operating conditions.Therefore, the subcritical growth of corrosion or crack-like defects, caused by the combined action of operating loads and media is crucial. In current approaches, these processes have not yet been sufficiently investigated and are not taken into account when predicting the performance of oil pipelines, in particular degradation of physical and mechanical properties of the metal used.

Engineering evaluation of the rate of corrosion failure of oil pipelines, taking into account both mechanical and physicochemical parameters of the interaction of the deformed metal with the working medium was carried out in the paper. The characteristics of the cyclic corrosion crack resistance of the metal of the pipe of oil pipelines taking into account the effect of operational factors.

New data about the features of corrosion-fatigue failure of pipes depending on the original sizes and shape of the defects were obtained. Diagrams of cyclic crack resistance of unexploited and exploited pipe steels 10Г2БТЮ3 and steel 20 were built. It was found that the water corrosive media (soil and distilled water) significantly affect the propagation process of fatigue crack in the studied steels.

**Keywords**: oil pipeline, crack-like defect, diagram of cyclic corrosion crack resistance, stress intensity factor.

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## NEW INTERCALATION MODIFIED STRUCTURES OF NATURAL MINERALS FOR HIGH-EFFICIENT Li+-CATIONIC ELECTRICITY GENERATION (p. 56-65)

**Ivan Grygorchak, Roman Shvets, Tetiana Bishchaniuk, Vasyl Baluk, Andriy Kurepa, Yuriy Kulyk, Yuriy Sementsov, Galyna Dovbeshko**

The possibility of a direct application of natural minerals of gibbsite ($Al(OH)_3$), chalcopyrite ($CuFeS_2$) and multigraphene for the efficient $Li^+$ – intercalation current formation was experimentally justified. The reason for studying these materials is that they are cheap, environmentally-friendly, affordable and abundant in nature. The dependences of changing the Gibbs free energy and the kinetic parameters of the intercalation reaction on the degree of "guest" lithium loading were analyzed for these materials. It was shown that the distinguishing feature of the $Li^+$ – intercalation current formation in structures under study was that it was significantly affected by the energy topology of surface states, controlled by the nanoscale dimensionality of the power generating particles and their molecular environment, therefore, acting as a powerful "tool" to improve power-generating capacities of the cathodes of the current lithium sources. Based on the data obtained by the impedance spectroscopy, X-ray diffraction analysis and light-scattering spectroscopy, a mechanism of the observed phenomena was proposed.

**Keywords**: gibbsite, chalcopyrite, multigraphene, supramolecular structure, intercalation, Gibbs energy, Nyquist diagram, diffusion coefficient.

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## OPTIMAL PARAMETERS OF ELECTROHEATING OF THE IMPLANTS (p. 65-69)

**Vitalii Honcharov**

The metal foil carriers for the catalysts with internal electroheating were studied in the paper. The samples were synthesized by implanting aluminum ions into a stainless foil and a subsequent impregnation with palladium. An important characteristic for the catalysts is the process temperature. That is why, in this research, the implant surface temperature as a determining factor of a heterogeneous catalytic process was chosen as the objective function. Studying the effect of the electric flux power, air flow rate and synthesis on the sample temperature was carried out using the method for recovering one-dimensional dependencies. As a result of the modeling, the optimal ranges of varying the process parameters were determined. It was shown that the electric flux power and the synthesis had a significant influence on the surface temperature, and the effect of the air flow rate was negligible. The obtained results allow effectively controlling electricoheating of the steel samples and can be applied in the construction of heat-exchange and catalytic elements with internal heating.

**Keywords**: implantation, implant, method for recovering one-dimensional dependencies, catalyst, electroheating, surface temperature.

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