Informatics, computer engineering and control

EMBEDDED DATA BASE MANAGEMENT SYSTEM ARCHITECTURE DEVELOPMENT OF SMALL SPACECRAFTS

Yu.V. Konkin, A.N. Kolesenkov

A problem of designing database management systems (DBMS) for use on board of small space vehicles is considered. The purpose of the work is to develop the structure of on-board DBMS, description of the principles of functioning of its elements, as well as development of a universal data format. The proposed architecture of DBMS has low requirements for the performance of the on-board computer system and memory resources. Features of DBMS operation with a multilevel memory structure are considered. The components of physical structure of the database are identified. The analysis of access methods shows that the binary aligned tree method for accessing using the primary, unique, or foreign key is the most appropriate one for the task conditions. In order to reduce the amount of memory used, it is suggested not to index the foreign key, and perform record search when checking the referential integrity by sequentially viewing a table. To store data in the database, a format is developed that describes the physical structure of the database, which contains the parameters necessary for downloading information. The access to the data by the value of a key is based on the algorithm of traversing the binary tree. The experiments on the implementation of the developed database were conducted in the Microsoft Visual Studio Community programming system with possibility of cross-platform transfer of executable code

Key words: database, DBMS, satellite, preprocessing, on-board

EFFICIENCY IMPROVING OF OPERATIONAL CONTROL AND TECHNOLOGICAL COORDINATION PROCESSES BASED ON INTELLECTUAL APPROACH

A.N. Kozlova, M.A. Tsukanov, O.A. Bozhkova

The article deals with the problem of technological coordination and operational management of continuously-discrete production systems. The decomposition of the operational control task into the stages of tracking the operation of individual units, compiling and optimizing the manufacture schedule, verification the feasibility of implementing the constructed schedule in real manufacture conditions, adjusting the production schedule in on-line mode in the event of a mismatch between the actual and planned production situations, checking the possibility of the adjusted schedule implementation. As a research task, it is considered to increase the efficiency of solving the main problem of technological coordination associated with verifying the implementation of the compiled schedule based on the implementation of the production system model, represented by the sequence of individual technological aggregates. Each of them is discrete in its nature - with its beginning and ending, with output results or final output in each operation; however, in dynamics, the system operation is characterized as continuous-discrete. A review of formalisms describing the behavior of such systems is presented and their shortcomings are revealed. The possibility of using a fuzzy model for describing the main links of a complex structured production system in solving the planning problem at the stages of checking and adjusting the production schedule is considered. The model is tested on the example of steelmaking production

Key words: operation control, technological coordination, optimization, fuzzy logic, artificial intelligence

DEVELOPMENT OF AN ALGORITHM FOR FINDING AN OPTIMAL ROUTE IN URBAN ENVIRONMENT

S.A. Kovalenko, V.F. Barabanov, N.I. Grebennikova

Despite active use of information technology, the relevance of the problem of transport routing in urban conditions does not decrease over time, as practice poses increasingly complex problems, both in terms of the number of optimized parameters and the number of constraints taken into account when solving.

A rational algorithm for finding the optimal route is presented, taking into account the features of the directional grid, which makes it possible to reduce the number of computed paths, reducing the dimension of the original problem, thereby reducing the time for its solution. The algorithm is called "rational" but not "optimal", because the principle of forming an adjacency matrix is changed: exact values of the matrix are not calculated, but geometrical distances between points are used.

The advantage of this approach is the direct dependence of the accuracy of the algorithm on the kind of graph, since in the case of a large number of destinations, the search algorithm gives the best results from the point of view of computing resources, and the solution of the task of delivering goods using vehicles in a large city is rational.

Strict adherence to the delivery dates for the formation of rational routes helps to achieve not only minimization of operating costs, transportation of people, but also to reduce the costs of storing inventory in warehouses

Key words: routing problem, transportation algorithm for finding the optimal route, evaluation of algorithms

Energetics

ANALYSIS OF THE FUNCTIONING OF THE COMPRESSOR STATION ON THE CRITERION OF ENERGY EFFICIENCY

L.V. Bulygina, V.I. Ryazhskikh

Increasing the energy efficiency of compressor stations (CS) is an outstanding issue within the entire gas industry. Analysis and calculation of technological operating modes of the CPs is an integral part of the overall solution of the problem of ensuring energy efficiency and optimizing the operation of the CPs and the gas transportation system (GTS) as a whole. The main parts of the gas transportation system are reviewed in the article: compressor station, line section of the main gas pipeline, gas mixture vs. natural gas. Additionally, the calculation of the air cooling device (ACD) of gas (additional GTS particle) as a temperature reduction matter is reviewed. The issues of regulation of the operation of gas pumping units and ACD gas are revised.

The effect of the thermodynamic parameters (temperature and pressure) of the compressor station on the energy efficiency of the compressor station was also thoroughly investigated in the article. The effect of outlet pressure on local and system energy efficiency of the compressor station was assessed experimentally based on a linear compressor station with gas turbine gas compressor units GPA-16 installed on it. Calculation and analysis of the operation modes of the gas transmission system with three linear compressor stations were carried out according to energy efficiency criteria. The annual consumption of fuel gas in the section of the GTS and the power consumption of the compressor stations were adopted as criteria for energy efficiency.

Applying the methodology considered in the article for calculating the operational modes of the compressor station and regulating the output thermodynamic parameters of the compressor station will improve the energy efficiency parameters of the compressing process, reduce the power consumption of compressor stations and, as a result, will reduce the fuel gas costs

Key words: energy efficiency, compressor station, gas pumping unit, gas air-cooling unit

ANALYSING THE VOLTAGE LEVELS INFLUENCE ON THE POWER STATION AFFECTING MAXIMUM ALLOWABLE BALANCE OF THE FLOW OF ACTIVE POWER IN THE CROSS-SECTION

V.V. Petrov, A.A. Al'mendeev, V.I. Polishchuk

The development of the electricity growth generating and consuming facilities, the growing complexity of electric networks multiples and increases the complexity of the control modes for the power system as a whole. Improving the efficiency of the power management modes of large power systems is the most important problem facing the dispatching services of the 'System operator' and FGC UES of the Russian Federation. Currently, after having been used quite pro-actively, methods of operational management regimes demonstrate certain difficulties in exceeding the maximum flow of active power in a controlled cross-section, which may cause disconnection of customers, as means for emergency control, and as a result of operational activities. Presently, there is a critical demand for the expansion of the 'Arsenal of management tools for the weighted modes', which would be able to reduce or eliminate such power limitations.

In the framework of the research conducted on the managing of weighted modes of power systems authors used the specifically developed technique aiming at reducing the balance of the flow of active power in a controlled cross-section of large power systems via using the regulating effect of the load voltage.

As a result of adjusting the electric modes based on the developed technique, we are able to suggest that as the usage of the regulating effect of the load voltage was reduced, the balance of active power flow of 7.4% was achieved in the controlled section with the original value.

The use of the developed technique allows to expand the above mentioned arsenal of operational control used in solving the problem of preventing development and elimination of invalid balance of exceeding-the flow of active power in a controlled cross-section of the power system. The reliability of the obtained results is confirmed by the identity of the synthesized models – models used by the staff of the System Operator, as well as by the strict adherence to the accepted methods of calculating of electric modes

Key words: power system, static load characteristics, voltage, maximum permissible flow

THE ANALYSIS OF THE CURRENT STATUS OF THE ERGODIC ELEMENT IN CONTROL SYSTEMS OF THE POTENTIALLY-DANGEROUS PRODUCTIONS

Yu.V. Klepach, S.A. Tkalich, V.L. Burkovskiy

Paper analyzes the current state of the ergodic element in the systems of safety control of complex technical systems. The determinative psychological aspects of personnel performance managing potentially dangerous technological processes are reviewed. The emphasis is placed on such factors as human factor, emotional state, motivation, psychological susceptibility of the means designed for forecasting emergency situations. Special attention is paid to the initial reasons for emotional tension and, in particular, excessive motivation, which generates the syndrome of professional burnout.

New method for reducing the 'working stress factors' due to the rational labor organization is suggested by creating automated means for forecasting contingencies that can anticipate operator actions and minimize the risk of panic. Eliminating the possibility of influencing the course of the process by the personnel error minimizes the impact of the human factor on the probability of an accident. Both technical and economic assessment of the reduction of technical risk for the forecasting system was made by minimizing the influence of the human factor.

The article provides an example of calculation of expected economic effect of introducing the system for forecasting of emergency situations in the chemical, pharmaceutical and nuclear industry. Peculiarities of the psychological susceptibility of forecasting means taking into account the 'sectoral orientation' of the training provided to the specialists are reviewed. The priority task of the forecasting system is identified as forecasting possible psychological protest by the personnel of the operating at the emergency systems. The predominant principles for the positive psychological perception of a person's resources employed within the emergency prediction system are formulated: trust in resources, convenient interface, simplicity of process mapping, organic sound and light support, restricted access for the incompetent personnel

Key words: human factor, emotionality, motivation, psychological susceptibility, emergency situation, forecasting system

Radio engineering and communication

INFLUENCE OF APPLIED SHOCK PARAMETERS ON THE DYNAMIC CHARACTERISTICS OF THE THIRD LEVEL ELECTRONIC MODULES

P.V. Ievlev

Systematic studies of mechanical impacts in the form of direct single shock impulses of various forms on the radio-electronic modules of the third level by modeling in the CREO program complex are carried out. For this purpose, a verified model of a small-sized radioelectronic cabinet was used, in which guide ways of various types are provided to accommodate detachable and integral plug-in modules of a lower hierarchical level. The dependence of the structure response intensity on the form of the impulse, peak acceleration, duration of the impulse, and the rate of increase of the shock acceleration are established. The determining effect of the steepness of the shock impulse front on the character of the established dependences and on the "stiffness " of the impact is shown. It is established that the "stiffness" of the impact in the case of the multimodal system of the third level radio-electronic module is mainly determined by the steepness of the front, while the slope of the cut introduces minor corrections to the process in those cases when the duration of the cut becomes comparable with the duration of the front.

The obtained results are the basis for creating a database for modeling mechanical loads on lower-level radio modules (blocks, panels)

Key words: modelling, applied shock, electronic modules

SIMULATION OF IMPACT TESTS IN ELECTRONICS IN ACCORDANCE WITH STATE STANDARDS

V.I. Borisov, P.V. Ievlev, A.V. Muratov, T.L.Turaeva, A.V. Turetskiy

The requirements for physical and mathematical design models of structures are considered, as well as possible options for simplifying the models. A brief review of physical and mathematical shock impact models, which are of the greatest practical interest, is given. The classical Newton impact model, Kelvin - Voigt, Bingham, Maxwell and Hertz viscous-elastic models of impact force in the initial and modified versions are considered taking into account nonlinearity of the elastic and viscous components. Examples of the effective use of viscous-elastic models for solving practical problems of shock actions on radio electronic products are given. The main reasons for the discrepancy between the results of finite element modeling and the results of full-scale tests are named.

The results of model tests of the radio-electronic module (REM) of the third level in the design phase by three successive impacts with the peak acceleration of 25g and the duration of 11 msec are presented in accordance with the current state standard

Key words: modelling, impact, electronic modules

ALGORITHM OF DIGITAL COHERENT DEMODULATION OF BINARY SIGNALS WITH DIFFERENTIAL PHASE KEYING AND ITS INTERFERENCE IMMUNITY

A.N. Glushkov, E.S. Gerasimenko

The article deals with the problem of signal processing and creation of noise-immune communication. Proofness to various types of distortion, increase in speed and increase of noise immunity are important tasks that are put before the developers of the equipment for signals receiving and processing. Within the framework of the research and solving the problem, a modernized algorithm of coherent signal demodulation is considered. The text shows the block diagram and discusses the operation principle of the proposed algorithm for digital coherent demodulation of binary signals with differential phase-shift keying, its advantages and disadvantages are indicated with respect to other known algorithms. A statistical simulation of the device has been made, which will work on the basis of the proposed algorithm for digital coherent demodulation of binary signals with differential phase-shift keying. The developed algorithms and the corresponding device for coherent digital demodulation of signals with binary phase-shift keying and differential phase-shift keying can be used to create an interference-proof connection. As a result of the simulation, an estimation of noise immunity of coherent demodulation of binary signals with differential phase-shift keying has been carried out, it is shown that the proposed digital demodulation algorithm proves to be optimal. The probability of an error of the digital demodulation of signals with four-position differential phase-shift keying is determined, the high efficiency of the demodulator is shown in the absence of the phenomenon of "sign ambiguity"

Key words: algorithm, coherent demodulation, differential phase-shift keying

INVESTIGATION OF THE RANK-ALGORITHM OF FHSS DETECTION

P.E. Bizyukov, V.P. Litvinenko, Yu.V. Litvinenko

The article considers the ranking algorithm for detecting a signal with frequency-hopping spread spectrum (FHSS) and the effect of signal parameters on its characteristics. The proposed algorithm is non-parametric, bases on a criterion of average rank and requires minimal a priori information about the parameters of the detected signal. The statistical characteristics of ranks are determined. A program of statistical simulation is developed using the package MATLAB, which allows to research the properties of the detection algorithm and to estimate the probabilities of false alarm and signal skipping. The graphs illustrating the procedure for finding the common minimum average rank are given. Recommendations for finding the value of the optimal threshold of signal detection are obtained; and the threshold's dependence on the signal parameters is investigated. The influence of the duration of the signal with FHSS on the reliability of its detection is determined; it is shown that increasing the detection time leads to a decrease in the probability of an error. The effect of the duration of an individual element of a signal with FHSS on the values of error probabilities and on the value of the decision threshold is considered. It is shown that its decrease leads to an increase in the error probability and a decrease in the value of the optimal threshold

Key words: ranking algorithm, frequency-hopping spread spectrum (FHSS), signal detection, modeling, MATLAB

MODEL OF EXTERNAL ENVIRONMENT STATES IN ASSESSING THE OPTICAL VISIBILITY OF GROUND OBJECTS IN THE INFRARED WAVELENGTHS RANGE

V.G. Kerkov, V.D. Mochalin, G.L. Tyurin

The article is devoted to investigation and revealing the regularities of the influence of various external environment states on the evaluation of the ground objects optical visibility in the infrared wavelength range and justification of the model of external environment states that allows to estimate the maximum values of the absolute thermal contrast of an object according to the set of possible external environment states.

Development of this model is determined by the need to reduce the quantity of measurements provided by a large number of parameters and environmental characteristics that are taken into account, varying depending on the state of the atmosphere, time of day and season.

To substantiate the minimum number of the environment states in which the extreme values of difference in radiation temperatures are observed, regardless of the characteristic values of objects, the influence patterns of various environment states on the optical visibility of ground objects in the infrared wavelength range are studied. Four groups of external environment states that guarantee finding for contrast extremes of surface object elements in a set of external environment states are defined. This guarantee is ensured, with other things being equal, by the maximum difference in the contrast of the surface object elements in the maximum and minimum cloudiness and taking into account all possible qualitative relations of the external environment characteristics.

The values of the external environment characteristics that provide assessment of the extreme values of the contrasts of the surface object elements are calculated.

Key words: model of the external environment states, optical visibility, thermal contrast, temperature distribution

Mechanical engineering and science of machines

EXPERIMENTAL INVESTIGATION OF VIBRATION APPLICATION ON THE ELECTROCHEMICAL DIMENSIONAL PROCESSING

A.I. Boldyrev, A.A. Boldyrev, V.V. Grigorash

During electrochemical dimensional processing due to clogging of the inter-electrode gaps, short circuits often occur, which lead to destruction of the working part of a tool electrode. To stabilize anodic dissolution in industrial production, various technical solutions are used. However, they are not always effective enough, because they often lead to a decrease in productivity and accuracy of processing.

In the paper, the results of experimental studies on eliminating the clogging of the inter-electrode gaps during electrochemical dimensional processing are considered. It is suggested to reduce the formation of clogs by applying vibration to the electrodes, which would help eliminate the inhomogeneity of the medium, the flow disruption, and remove the near-anode film from the working zone. The studies were carried out in an electrochemical cell using an experimental unit, where it was possible to apply oscillations of the frequency 20, 40, 80 Hz with the amplitude of 0.15 mm to the tool electrode. Comparative studies were conducted without applying vibration to the electrode tool.

As a result of the research, it was established that the vibrations applied to a tool electrode during electrochemical dimensional processing significantly reduce the possibility of clogs in the inter-electrode gap. Superimposed vibrations lead to a certain increase in the productivity of the process compared to the treatment without vibration. At the same time, there was no significant effect on the accuracy

Key words: electrochemical treatment, vibration, elimination of blockages

DOSING THE IMPACT ENERGY FOR OBTAINING BRIQUETS OF PREDETERMINED DENSITY FROM CUTTING CHIP

I.A. Checheta, A.E. Checheta

It is shown that the set density of briquettes obtained from metal chips by high-speed impact is predetermined solely by observing the condition that the values of the true relative deformation of the chip material and the density of the briquette created are equal. This condition is predetermined by the essence of the patent received by the authors for the invention [4], the patent holder of which is the Voronezh State Technical University. The materials of the patent, together with the materials of the author's certificate [3], obtained earlier, concerning the energy dosing for the dynamic deformation of samples from continuous material, predetermined the possibility to calculate not only the amount of energy required to create a specified density, but also the temperature during the impact in the process of briquetting. In turn, in any case, the presence of a blow predetermined the need to consider the process of dynamic deformation as a complex multi-tiered system capable of development and improvement. As the basic components of this system, it seemed necessary to distinguish three subsystems: material, energy and technical environment, in which interaction between the material and the energy introduced is realized. At the same time it is taken into account that the essence of the technical environment is manifested by some property of the matter: the force field, magnetism, temperature, time interval, positive or negative catalyst

Key words: energy, true relative deformation, porosity

DIFFUSION WELDING OF TITAN USING PRESSURE IN THE INITIAL STAGE

V.V. Peshkov, A.B. Bulkov, I.B. Korchagin, S.M. Larsov

The article describes the technological process of diffusion welding of titanium structures. The feature of the technology under consideration is the removal of the external compressive pressure at the final stage of welding to reduce the accumulated deformation of the welded blanks.

Experimental studies were carried out on cylindrical samples of the OT4 alloy with initial globular microstructure. The welding was carried out in the vacuum 2.6 Pa at 850-950 °C and the holding time 10-90 min under the pressure 2 MPa. In the second stage, the samples were subjected to isothermal annealing in argon medium for 60-180 minutes.

The bond quality was evaluated by the static tensile strength. To determine the mechanism of bond zone formation, the microstructure of the samples and the topography of the fracture surface were investigated.

It is shown that in the case of diffusion welding of titanium alloys with an initial globular (equiaxed fine-grained) microstructure, the value of the accumulated deformation of the welded blanks can be reduced by more than 2 times. It is proposed to carry out the welding process in the temperature range of polymorphic transformation, using the welding pressure only at the first stage to form a physical contact with the area at least 50% of the nominal one, and then to produce isothermal annealing without pressure. The dependence of the duration of isothermal annealing on temperature is established, which makes it possible to obtain a compound that is equivalent to the main material

Key words: titanium alloy, microstructure, diffusion welding, microrelief

Physics

EFFECT OF HEAT TREATMENT ON ELECTRICAL PROPERTIES TWO-LAYER THIN-FILM STRUCTURES ZnO/$Zn_xFe_{1-x}O$

I.S. Ilyashev, Yu.E. Kalinin, V.A. Makagonov, S.Yu. Pankov, A.V. Sitnikov

Thin films of ZnO, $Zn_xFe_{1-x}O$ and double-layered ZnO/$Zn_xFe_{1-x}O$ thin-film structures were prepared by ion-beam sputtering. XRD analysis of the ZnO and $Zn_xFe_{1-x}O$ samples showed that the films are crystallized in hexagonal wurtzite lattice (space group P63mc). The effect of heat treatment on electric properties of ZnO, $Zn_xFe_{1-x}O$ thin films and double-layered structures ZnO/$Zn_xFe_{1-x}O$ have been investigated after thermal annealing at 400°C during 30 minutes in vacuum and in air atmosphere. The dependencies of thermovoltaic response of double-layered structures ZnO/$Zn_xFe_{1-x}O$ at 25 – 350 °C showed that after heat treatment in vacuum and air atmosphere, the value of thermovoltaic response is decreased. Thermal annealing leads to increase of resistivity that can be explained by the reduction of carrier concentration and a change of charge carriers' mobility. The activation energy of charge carriers' mobility for synthesized structures has been evaluated. Paper shows that the annealing in vacuum for all samples leads to an increase in ΔE, which can be associated with an increase of the hopping length between localized states

Key words: oxide semiconductors, electrical resistivity, thermovoltaic effect, thermopower, heat treatment

SIMULATION OF METHANE SORPTION AND DESORPTION IN SILICALITE

D.S. Kutsova, E.V. Bogatikov, A.N. Shebanov, D.G. Kulikov, E.N. Bormontov

Increasing the efficiency of methane desorption from silicalite with the use of oscillating heating is discovered by the method of molecular dynamic modeling in the LAMMPS package. In molecular dynamics modeling, a dynamic model of the zeolite framework was used on the basis of the binding potential, which includes a harmonic term and a three-particle term. To describe the interactions between the adsorbent and the zeolite, the Lennard-Jones potential was used. Such potentials allow adequately reproducing both the interaction of the zeolite framework with the adsorbent and the effect of temperature on the kinetic processes in the zeolite-methane system. Kinetic dependencies for sorption and desorption processes at various temperatures are obtained. A temperature range has been discovered for which the rate of desorption of methane from the filled zeolite exceeds the rate of sorption of methane by an empty zeolite. The result obtained makes it possible to explain the efficiency of oscillating heating. The balance equation for the kinetics of sorption-desorption processes is solved. The results of molecular dynamics modeling are used to find the temperature dependences of the parameters of the balance equation. Based on the kinetic model of sorption-desorption processes, it is shown that the increase in the desorption efficiency under oscillating heating is indeed due to the form of the temperature dependence of the rates of sorption and desorption. The use of oscillating heating for the regeneration of a gas sensitive layer of sensors based on silicalite is proposed

Key words: silicalite, methane, sorption, molecular dynamics

MODELING THE PROCESSES OF FORMATION OF THERMO-ELECTROKINETIC EMF IN THE CONDITIONS OF NON-STATIONARY HEAT-ASSISTANCE IN CONDENSED ENVIRONMENT

A.V. Sidorov, V.M. Grabov, A.A. Zaitsev, D.V. Kuznetsov, D.A. Nartsisov

Based on the comparison of the results of a computational and full-scale experiment, the investigation of the thermo-electrokinetic effect is made: the cross-effect formed in viscous electrically conductive environment with the participation of three thermodynamic forces described in the thermodynamics of irreversible processes. The mathematical model of the phenomenon is substantiated by the system of nonlinear, non-stationary partial differential equations written for a continuous electrically conductive medium from the equations of mass, energy, and electric charge balance. An algorithm for calculating the thermo-electrokinetic EMF (TEK EMF) is formulated, and a computational experiment is performed on the basis of the constructed model. In the course of the computational experiment, the value of the TEC EMF is calculated for different values of mobilities and heat transfer of ions of the electrically conductive medium. Its temperature and concentration, the contribution of the accompanying effects is also estimated. Comparing the obtained calculated dependencies with the available experimental ones allows us to conclude that the model constructed adequately describes the main qualitative laws of the thermo-electrokinetic effect. Further improvement of the model will make it possible, on the basis of a quantitative comparison of the results of a laboratory and a computational experiment, to refine the important characteristics of electrically conducting environment and to establish a detailed microscopic mechanism for the formation of new, recently discovered thermo-electrokinetic phenomena

Key words: mathematical modeling, cross effects, thermodynamics of irreversible processes, heat and mass transfer

THEORETICAL STUDY OF INTRINSIC SPIN POLARIZATION AND SIZE-DEPENDENT MAGNETISM OF ULTRA-SHORT CARBON NANOTUBES (0,9)

G.I. Glushkov, A.V. Tuchin, E.N. Bormontov

The main problems and significant parameters of new materials search and development for spin electronics - spintronics – are addressed in the article. The solution, which satisfies the conditions of reproducibility, intrinsic spin polarization existence, the dependence of conductivity on electron spin the ultra-short cabron nanotubes were reviewed. It is discovered that the so called “3k rule” is violated in a narrow interval of lengths, and the tube exhibits semiconductor properties, whereas the gap between the boundary orbitals depends on the spin of the carrier. The analysis of the electronic structure of the ground and excited states confirms the dependence of the conductivity on the spin of the carrier. The possibility of modulating the spin polarization by applying external electric fields and doping with metallic impurities is investigated. Within the small range of length the tubes act as a semiconductor and the energy gap between frontier orbitals depends on electron spin. The analysis of electron structure of the ground and exited states demonstrates such conductivity dependence as well as the possibility of electron structure modulation by means of strong electric fields and metal doping. The spin polarization increase twice as much and the increase of the difference between opposite spin electrons conductivity was shown in external fields. For the first time the spin polarization inversion effect was observed in carbon nanotubes: the inversion of spin of the main conductivity channel electrons. The relative binding energy calculation shows high structure stability in the whole range of lengths considered in the paper. The role of doping in a total effective magnetic momentum: the doping modulates the electron structure and increases the spin polarization degree but does not cause it, there is a great role the pure carbon structure to effective magnetic response. Thus, the ultra-short carbon nanotubes satisfy all the conditions to be used for functional spintronic devices

Key words: spin, spin polarization, spintronics, carbon nanotube

DIELECTRIC PROPERTIES OF Rb_2ZnCl_4 - SiO_2 NANOCOMPOSITES

T.N. Korotkova, **L.S. Stekleneva**, **E. Rysiakiewicz-Pasek**, **L.N. Korotkov**

The matrix nanocomposites of Rb_2ZnCl_4 - SiO_2 system were prepared by embedding of ferroelectric with incommensurate phase Rb_2ZnCl_4 into porous glasses with average diameter of through pores near 320, 160 and 23 nm from saturated aqueous solution. X-ray analysis revealed that the crystallized in porous material and bulk Rb_2ZnCl_4 possess identical crystalline structure. Comparative study of temperature dependences of dielectric permittivityε for prepared composites and the bulk Rb_2ZnCl_4 single crystal were carried out within temperature range of 120 – 350 K. It were found the maxima of ε in the vicinity of temperatures T_i and T_C corresponding to structural transitions from paraelectric to incommensurate and from incommensurate to ferroelectric phases. Dependencies of ε(T) are obeyed to Curie - Weiss law within a wide temperature range above T_C. In immediate proximity to T_C the ε(T) curves for Rb_2ZnCl_4 - SiO_2 composites are described more precisely by so called “square Curie - Weiss law”. It was found the weak increase of T_i in embedded salt in comparison with the bulk Rb_2ZnCl_4**.** Transition from incommensurate to ferroelectric phase in ultradisperse Rb_2ZnCl_4 is diffused and its temperature is decreased considerably

Key words: incommensurate phase, nanocomposite, porous glass, ferroelectric phase transition, dielectric permittivity

MODERN HYDROGEN STORAGE BASED ON HYBRID FUNCTIONAL MATERIALS

A.V. Zvyagintseva, A.O. Artemieva

The article introduces the process of developing and researching a hydrogen hydride storage system that meets the requirements of safe storage at relatively low operating costs. The ability of electrochemical systems to absorb hydrogen is studied for the first time. To experimentally confirm the assumption that in electrochemical systems ‘intermetallics’ can be a structural trap for hydrogen atoms, a system which according to the literature is traditionally not inclined to absorb hydrogen and form the metal-hydride phase-the electrochemical composite of Ni-In, is on-purposely chosen here to demonstrate the above processes. The research ways and methodology for the synthesis of structures of electrochemical composites Ni_x-In_y-H_z based on nickel with an intentionally increased degree of defectiveness are introduced in the article. For electrochemical systems, deuterium was used as the test gas for the first time of studying hydrogen sorption and thermal desorption. Samples with different indium contents were made. The optimum mode of applying nickel samples was determined experimentally - via the density of the cathode current and the temperature of the electrolyte. The electrochemical composite Ni-In with a phase composition - $Ni_{70}In_{30}$, which has a structure providing the retention of the doped deuterium (hydrogen) is synthesized. It is shown that the hydrogen content in the experimental samples of the Ni_x-In_y-H_z, composite, determined by thermal desorption, is up to 8 wt. %, which further confirms our statement that the galvanically obtained composite has the ability to accumulate hydrogen and further preserve it in the form of metallic hydrides

Key words: nickel, indium, indium intermetallics, ion implantation, hydrogen storage

BARIC PROPERTIES OF 2D LAYER STRUCTURES WITH A DIFFERENT TYPE OF INTER-LAYER INTERACTION

A.V. Tuchin, Yu.V. Kasper, T.V. Kulikova, L.A. Bityutskaya, E.N. Bormontov

The combination of high mobility of electrons and holes, thermal conductivity and thermodynamic stability led to strong research activity in studying graphene and finding of new graphene-like layered materials, such as 2D silicon carbide. The actual problem is the determination of ways to control the properties of 2D layered materials external influences such as electromagnetic fields, pressure. The aim of this work is a theoretical study of the restructuring of the electronic structure of multilayer structures of graphene and silicon carbide with the number of layers from 1 to 3, subject to uniaxial compression. A stabilization of the structures during their layer-by-layer growth was revealed. Equipped with a linear pressure dependence of the effective charge of two - and three-layer multigravida. Discovered a threshold change in conductivity for the two - and three-layer graphene at the critical pressures of 20 and 30 GPA, which is determined by the formation of interlayer conductivity channels. Installed directly proportional relationship of the band gap SiC for high blood pressure. Thermodynamic stability of layered structures of graphene and silicon carbide, the sensitivity of their electronic structure to external pressure to open up the possibility of controlling their electrophysical properties and external mechanical influences

Key words: layered materials, multigrain, silicon carbide, electronic structure, pressure

LINEAR AND NONLINEAR DIELECTRIC RESPONSE IN NANOSTRUCTURED BARIUM TITANATE

O.I. Sysoev, T.N. Korotkova, V.V. Zaporozhskiy, D.A. Lisitskiy, L.I. Yanchenko, N.A. Emelianov, L.N. Korotkov

By compaction of barium titanate nanopowder (BaTiO3) followed by annealing in air at a temperature of 1200 ^{o}C, samples of nanostructured barium titanate with an average crystallite size of about 50 nm were obtained. Based on the results of X-ray analysis and the studies of the temperature dependencies of the dielectric permittivity in the temperature range 20-200 ° C, it was found that the material undergoes the first-order ferroelectric phase transition at a temperature of 140 ° C. The reversive dielectric nonlinearity of the material in the electric field range 0 ± 4 kV / cm was studied. The nonlinearity of the dielectric constant found within the ferroelectric phase corresponds qualitatively to the predictions of the phenomenological theory of first-order ferroelectric phase transitions. Along with this, the authors justify the existence of areas of the ferroelectric phase, which are stabilized, presumably, by crystal lattice defects substantially higher than the T_C. Analysis of the shape observed in the polar phase of the electric field dependence of the dielectric permittivity indicates the existence of a domain structure in the material under study

Key words: nanostructured ferroelectric, phase transition, dielectric nonlinearity, domain mechanism