ABSTRACT AND REFERENCES

APPLIED PHYSICS

SOFTWARE SYSTEM DEVELOPMENT TO CALCULATE ELECTRO-OPTICAL CHARACTERISTICS OF ORGANIC LIGHT-EMITTING STRUCTURES (p. 4–7)

Zenon Hotra, Khrystyna Ivaniuk, Marian Chapran, Ores Bilas, Orestes Malanchuk

The current state of development of organic electronics was analyzed in the paper. The problem of elaborating low-cost express measurements of chromatic and luminance characteristics as an alternative to costly, located in specialized laboratories was considered.

Methodology for determining the chromatic characteristics of organic light-emitting diodes (OLED), adapted to planar light-emitting structures was developed. The software to calculate the basic electro-optical characteristics of OLED, namely chromatic, luminance and current-voltage characteristics of organic light-emitting diodes according to the previously developed calculation methodology was designed.

The developed software solves the problem of cumbersome calculations of basic electro-optical characteristics of OLED, it is adapted to a modern operating system, provides calculation correctness and accuracy, easy interface to effectively solve the computational problem for the platform.

Keywords: chromaticity, luminance, OLED, light-emitting diodes.

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METHODS FOR RECOVERING THE DISLOCATIONS CONTOUR LINE OF GALLIUM ARSENIDE WAFER OF DIGITAL IMAGE (p. 8–16)

Andrey Samoilov, Igor Shevchenko

The production volume growth of high-speed semiconductor devices based on gallium arsenide determines the necessity of semiconductor wafers dislocations control effectiveness increase.

In the article the methods of etching pits contour dislocation of gallium arsenide wafers recover have been suggested. Pretreatment performs binarization of the plate surface images highlighting the contours of the present parts of the image. The improved method of the width of the contour line determination defines the width of the line bounds of etch pits in suspected dislocation taking into consideration the variability of their reflection in the binarized image. The current width of the contour line is compared to the standard line width of dislocation contour.

The recovering method of contour line determines the suggested bounds of dislocations monitoring changes in the direction of the dislocation contour line in the plane of the plate image based on the value of the dislocation contour line width. The recovering method of contour line branching takes into account various options of adjacency line and determines the direction of further recovering of etch pits dislocation contour lines. It has been given a stepwise description of the methods.

Keywords: dislocation, etching pits, contour line recovering, gallium arsenide, digital image.

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THE STUDY OF INERTIAL BROWNIAN MOTOR WITH FLUCTUATING POTENTIAL ENERGY SIGN (p. 17–20)

Nataliia Shkoda, Taisiya Korochkova, Viktor Rozenbaum, Irina Shapochkina

The model of a Brownian motor with potential profile fluctuating in the sign, which is described by piecewise-linear periodic function, not belonging to the classes of symmetric and antisymmetric functions was presented. The model with the potential of this type shows unidirectional motion just in the case when inertialess motion is prohibited. The simplicity of the potential profile makes the problem analytically solvable and greatly simplifies the symmetry analysis. In approximations of the adiabatic mode of fluctuations and low inertia amendments, an analytical expression for the average velocity of the Brownian motor, which is different from zero only at a non-zero mass of the particle, i. e., motor effect is purely inertial was obtained. The resulting expression depends on the mass of the particle, parameters of the nonantisymmetric potential profile, the friction coefficient of the particle and temperature. It is shown that by changing the values of the parameter characterizing the profile shape deviation from antisymmetric allows to control the motion direction, and the dependence of the average velocity on this parameter is non-monotonic.

Keywords: nanomachines, nanomechanisms, Brownian motors, molecular pumps, subsurface diffusion, nonequilibrium fluctuations.

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IMPLEMENTATION PLASMA CHEMICAL ETCHING IN SUBMICRON TECHNOLOGY WSI STRUCTURE (p. 21–24)

Stepan Novosyadlyy, Liubomyr Melnyk Svyatoslav Novosyadlyy

With the development of a range of sub–micron devices elements inthralnyh large schemes, a number of problems, which either did not exist in the development of technology of integrated circuits with minimum dimensions of elements, or they did not identify significant. Thus reducing the geometric dimensions topology structures LSI, accompanied by a decrease in the thickness of the functional layers of multilayer structures used to represent a theoretical requirements for selectivity and anisotropy etching layers introduced defects and radiation damage to the surface of the processed wafers of silicon or gallium arsenide structures of integrated circuits. To determine the optimal technological regimes digestion ranged basic operating parameters of the process – the composition and working gas pressure, bias voltage and holder, holder distance to the source plasma. This article reveals the same perspective and alternative use of submicron technology of plasma chemical etching.

Keywords: plasma chemical etching, deposition, boron phosphorus silicate glass, photoresist, reactor.

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THE CURRENT DISTRIBUTION IN THE ELECTRODES OF ELECTROSURGICAL INSTRUMENTS DURING WELDING OF BIOLOGICAL TISSUES (p. 24–28)

Volodymyr Sydorets, Andrey Dubko

The analysis of the current density distribution in the electrodes of electrosurgical instruments during welding of soft biological tissues was performed. For that, the solution algorithm was developed, and the elliptic problem that simulates the skin effect in the compact section conductors was solved. Verification of the mathematical model of the current density distribution in a monopolar electrode by comparing with the experimental data during surgical operation of welding the retina to the choroid was carried out. The mathematical model shows that high-frequency current hardly flows in a round electrode and this explains the formation of coagulation

rings in practical studies of contact retina welding. This model is a one-dimensional elliptic problem for modeling the skin effect in conductors. By changing the current frequency in the electrodes it is possible to influence the width of the coagulation ring and solve the problem of its optimization since too great width of the ring leads to a more traumatic course of the operation, and too small - does not provide the quality and strength of the weld.

Keywords: welding of soft biological tissues, electrosurgical instruments, electrodes, high-frequency current, skin effect.

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SENSITIVITY OF ACOUSTIC EMISSION AMPLITUDE-ENERGY PARAMETERS TO CHANGE IN PROPERTIES OF TREATED COMPOSITE (p. 28–31)

Sergii Filonenko

Control and monitoring of composite machining is an important task in ensuring the quality of manufactured products. One of the ways to solve the problem is using the acoustic emission method. Modeling of the change in the energy of acoustic emission signals in the composite machining, depending on the parameter that is determined by its properties was considered. Data processing showed that the increase in the influencing parameter leads to a drop in acoustic emission energy parameters. Herewith, the dispersion with an average energy level of the generated signal has the largest drop. Comparison of changes in the acoustic emission energy-amplitude parameters showed that with the increasing influencing factor, percent drop of dispersion of the average energy level outstrips the percent drop of its average level and standard deviation, as well as all the amplitude parameters of acoustic emission signals. The results show that the dispersion of the average energy level of acoustic emission signals can be used to develop methods for control, diagnosing and monitoring of the unevenness of the surface properties of manufactured products in the composite machining process.

Keywords: acoustic emission, composite, signal, amplitude, machining, material properties.

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NANOREFRIGERANTS APPLICATION POSSIBILITIES STUDY TO INCREASE THE EQUIPMENT ECOLOGICAL-ENERGY EFFICIENCY (p. 32–40)

Mykola Lukianov, Olga Khliyeva, Vitaly Zhelezny, Yury Semenyuk

The results of experimental and theoretical studies of the TiO_2 and Al_2O_3 nanoparticle additives in the working fluid R600a/mineral oil on the eco-energy efficiency of the compressor system have been considered. The experimental setup (refrigeration compressor system) and the experimental methodology have been described.

Following working fluids have been selected for compressor refrigeration system: R600a/compressor oil; R600a/compressor oil/nanoparticle TiO_2 (1,0 and 0,48 wt. %.) and R600a/compressor oil/nanoparticles Al_2O_3 (0,52 and 0,08 wt. %). The results of experimental studies of cooling capacity, compressor power and coefficient of performance at the different values of working fluid flow rate in the compressor refrigeration system have been reported. It was shown that the nanoparticle additives may lead to increase in energy consumption of the compressor system up to 23 % at flow rate of the working fluid equal to 0.00025 kg/s at the evaporator temperature 258 K.

The method of eco-energy analysis has been proposed to science-based evaluation of an expediency of nanoparticle additives to the refrigeration equipment working fluids. This method is based on assessment of total equivalent greenhouse gases emissions on the equipment life cycle (TEGHGE).

Expressions to assessment the value of TEGHGE and the specific eco-indicator have been proposed. The values of TEGHGE and eco-indicator on the life cycle of the compressor system based on experimental data obtained for the cooling capacity and compressor power for different working fluids have been analyzed. It was shown that Al_2O_3 nanoparticle additives with 0.52 % mass concentration provide the best eco-energy effect.

Keywords: nanoparticles, nanofluids, compressor system, cooling capacity, coefficient of performance, ecological-and-energy analysis.

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METHOD FOR DETERMINING THE BULK TEMPERATURE OF THE ACHESON GRAPHITIZATION FURNACE CORE (p. 41–46)

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In order to reduce energy consumption in graphitization of electrode products in Acheson furnaces, a method for rapid assessment of the bulk temperature of the furnace core, which is based on the furnace energy balance equation and takes into account active energy loss at the furnace entrance; heat loss from the core surface; heat loss and moisture evaporation; heat loss in the core booster gasification process was developed. The unknown coefficients of the method - the temperature dependences of the effective heat transfer coefficient from the core surface and the proportionality factor, which takes into account active energy loss in the direct core insulation heating, were determined by calculation using the verified numerical model of heat-electro-mechanical state of the Acheson furnace. Analysis of the results showed that the nature of temperature dependence of the proportionality coefficient, which takes into account active energy loss in the direct core insulation heating is similar to the temperature dependence of the specific electrical resistivity of the furnace core (core booster). Verification of the developed method showed good agreement with the numerical simulation results. The developed method was tested in conditions of the electrode manufacturer PJSC "Ukrgrafit", Ukraine and has allowed to reduce specific energy consumption while maintaining the necessary quality level of graphitized products.

Keywords: graphitization, Acheson furnace, gasification, energy loss, temperature, energy balance.

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SELECTIVE ETCHING OF DIAMOND SINGLE CRYSTALS OBTAINED BY THERMAL-GRADIENT METHOD (p. 47–50)

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Diamond single crystals were investigated using the selective etching. The crystals obtained by the thermal–gradient method using the Toroid type high– pressure device in the thermodynamic stability region at a pressure of 5.7–6.1 GPa and a temperature of 1420–1450 °C were examined. Diamond samples had a cubooctahedral habit with the size of 2–4 mm; the crystal weight of 0,1–0,26 ct. Studies were carried out on plates prepared by parallel plane grinding (100). Before etching, diamond crystals were purified with a mixture of hydrochloric and nitric acids, then washed with chromic mixture. Etching was carried out using potassium nitride and potassium hydroxide at atmospheric pressure and a temperature of 550÷580 °C in a platinum crucible. Experiments were performed in five stages, the total etching time – 85 min. A decrease in weight and changes in the etching patterns of diamond single crystals was observed. It was shown that diamond single crystals have a high perfection degree and low etchability at these temperatures.

Keywords: diamond single crystals, dislocation structure, selective etching, potassium nitride, potassium hydroxide, etch pits.

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ESTIMATION OF ATOMIC CHARGES IN BORON NITRIDES (p. 50–57)

Levan Chkhartishvili, Shorena Dekanosidze, Nodar Maisuradze, Manana Beridze, Ramaz Esiava

Boron nitrides (BN) are compounds with bonds of covalent–ionic type. Therefore, binding polarity is an important characteristic affecting their physical properties. Dependencies of measurable parameters on static effective charges of constituent atoms are so complex that, these are virtually undetectable experimentally. As for the theoretically obtained atomic charges in boron nitrides, they are characterized by a significant scatter making them almost unreliable. The general reason for this lies in the impossibility of unambiguous division of the electron density between atoms of elements. It pushes the search for a semiempirical solution of the problem.

We have derived the expression for the effective charge number q in a binary compound (effective charges of B and N atoms should be +qe and –qe, respectively) depending on number of molecules N in primitive parallelogram, its sectional area S transverse to the external electric field direction, Young's modulus Y and permittivity ε in same direction. Semiempirically estimated values of q (in a- and c-directions) are physically reasonable: hexagonal h-BN – 0.35 and 0.09, cubic c-BN – 0.49, and wurtzite-like w-BN boron nitrides – 0.76 and 0.50.

Also quite natural are qualitative conclusions: in h-BN intralayer bonds polarity is much stronger than that between hexagonal layers; bonds are stronger polarized in denser modifications c-BN and w-BN, which are characterized by higher coordination numbers as well; bonds polarities in c-BN and along c-axis in w-BN are almost indistinguishable; and bonds polarities in a- and c-directions in w-BN are different.

Obtained static charges can be used in the refinement of the BN electron structure calculations.

Keywords: point atomic charges model, semiempirical estimates, boron nitrides.

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