ABSTRACT AND REFERENCES

APPLIED PHYSICS.

MODELING AND VALIDATION OF MAGNETIC FIELD DISTRIBUTION OF PERMANENT MAGNETS (p. 4–11)

Alicja Prachukowska, Michal Nowicki, Igor Korobiichuk, Roman Shewchyk, Jacek Salah

The results of three-dimensional modeling of the magnetic field distribution of permanent magnets were presented. The developed method for modeling the magnetic field distribution of the permanent magnet with the set geometric parameters was also given. For three-dimensional modeling, open source software ElmerFem, where calculations were performed by the finite element method was used.

Experimental studies of the distribution of the magnetic field, originating from real magnets, in order to verify the model used in modeling were conducted. Correction of the model used in modeling was carried out based on the experimental studies. Verification of the developed method by modeling and measurement of permanent magnets was also performed. The results of experimental studies and theoretical modeling were almost identical, which validated the developed method for modeling the magnetic field distribution of permanent magnets. The developed method can be used in solving applied problems of calculating the three-dimensional distribution of magnetic fields of permanent magnets, which are used in designs of electric machines, electromagnetic transducers.

Keywords: magnetic field, FEM modeling, Elmer, permanent magnets, finite element method.

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X–RAY ANALYSIS OF IRRADIATED NUCLEAR GRAPHITE OF GRADES ARV AND MPG (p. 12–16)

Anton Komir, Nikolai Odeychuk, Alica Nikolaenko

In connection with the research of structural materials for Generation IV nuclear energy systems, there is interest in increasing the accuracy of simulating the hypothetical accidents such as atmosphere entry into the core. To substantiate the possibility of using the concept of oxidation simulation by the finite element method with isotopic properties, a study of the anisotropy of the crystal structure of nuclear graphite produced by isostatic compression is needed.

X-ray analysis of nuclear-grade graphite ARV and MGP in the initial and the irradiated state is performed in the paper. Three different phases of graphite due to the method of production were identified. The influence of gamma radiation and streams of high-energy electrons on the crystal structure was examined. The issue of epy anisotropy of epy crystal structure and its change under ionizing radiation was investigated. The hypotheses of a slight anisotropy of the crystal structure of the studied graphite grades were confirmed.

Keywords: nuclear-grade graphite, X-ray analysis, pole figures, ionizing radiation, crystal structure.

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INVESTIGATION OF TEMPERATURE EFFECT ON MAGNETIC CHARACTERISTICS OF MANGANESE-ZINC FERRITES (p. 17–21)

Maciej Kachniarz, Jacek Salach, Adam Bienkowski, Roman Shewczyk, Igor Korobiichuk

The results of investigating the temperature effect on the characteristics of the soft magnetic crystalline materials were presented. Four manganese-zinc ferrites having different compositions of manganese and zinc were examined. The materials studied were shaped as ring cores with a closed magnetic circuit. Each core was wound with the magnetization winding and the measuring winding. Each sample thus created was installed in a cryostat, which was used for stabilizing a predetermined temperature. The magnetic characteristics were measured by a computer-controlled measuring system.

The research results indicated a significant relationship between the temperature and magnetic properties of manganese-zinc ferrite. Temperature increase led to lower values of all the parameters of the hysteresis loop: the coercive field, the induction of the residual magnetization and the maximum induction. At low temperatures below 0 °C, the maximum induction reached its highest values: 450 T in the sample N41, 370 T in the sample F3001, 360 T in the sample F807, 440 T in the sample T38, and at higher temperatures, the induction began to decrease. The described phenomenon may find practical use in the manufacture of temperature sensors.

Keywords: ferromagnetic material, ferrite, magnetic characteristics, temperature effect.

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SIMULATION OF THE THERMAL STATE OF THE PREMISES WITH THE HEATING SYSTEM «HEAT-INSULATED FLOOR» (p. 22–27)

Mykola Sotnik, Sergey Khovanskyy, Iryna Grechka, Vitalii Panchenko, Maria Maksimova

Application of computer numerical simulation of aerodynamic and heat and mass transfer processes in premises with a radiant heating system "heat-insulated floor" using the software package ANSYS CFX is considered. The main objective of the research is to improve the energy efficiency of thermal energy in premises based on the analysis of their thermal modes. As the object of research, thermodynamic parameters of the thermal state of the premises with a radiant heating system "heat-insulated floor" were selected. The results of simulation of the thermal state of premises allow to carry out a study of the influence of non-stationary processes in the internal volume of premises on the overall thermal state and obtain analytical dependencies of changes in the thermal state parameters of premises on the time of its heating. The research results can be applied by energy auditors in the field of power engineering to assess compliance with the comfort conditions in the premise, analyze its thermal state, evaluate the effectiveness of various energy-saving measures.

Keywords: radiant heating system, numerical simulation, thermal state of premise, "heat-insulated floor".

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THE STUDY OF UNEVEN TEMPERATURE FIELD IN BILLET ELECTRODES DURING THEIR GRAPHITIZATION IN THE CASTNER FURNACE (p. 28–32)

Serhii Leleka, Taras Lazarev, Anatoliy Pedchenko, Denis Shvachko

We have experimentally studied the thermal and electric state of the Castner furnace, which allows adjusting and verifying the numerical data-based model. The analyzed physical experiment findings show that the billets which contact with a large volume of insulation material within a certain temperature range have a slightly reduced heating rate, which is probably due to the fact that some heat is spent on evaporation and further gasification of the carbon material.

We have also found that the use of a ring-shaped interelectrode gasket affects the temperature distribution in the fore part of the electrode billets since the shape of the gasket allows reducing the temperature difference along the axis of the central pieces. The obtained values of the water temperature spent on cooling of the electrical shunt allowed calculating an effective coefficient for the heat transfer from the surface of the graphite shunt to the cooling belt.

The study has proved that the effective heat transfer coefficient has a constant value till the shunt surface temperature reaches the rate of 140 °C. If the temperature exceeds this level, the coefficient value grows because of the lower thermal contact resistance between the cooling belt and the graphite shunt due to the thermal expansion of the latter.

Keywords: graphitization, electrode products, gasification, direct heating furnace, electric contact gasket, current shunt.

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DEVELOPMENT OF TECHNOLOGY OF MULTICHARGED ION IMPLANTATION OF GaAs FOR SUBMICRON STRUCTURES OF LARGE-SCALE INTEGRATED CIRCUITS (p. 32–40)

Stepan Novosyadlyy, Sergiy Bojko, Liubomyr Melnyk, Svyatoslav Novosyadlyy

The paper describes the development of technology of multicharged ion implantation for GaAs. This technology is essential to creating high-performance VLSI structures. The main advantage of ion implantation of GaAs is optimizing the doping profile for the active impact on the characteristics of Schottky field-effect transistors, namely reducing the surface influence on the stability of Schottky transistors and enhancing their performance by reducing the resistance of the source and drain regions. The first section of this paper presents the results of developing the GaAs-based structures with steep Schottky barrier. Next, the technology of multicharged ion implantation of P and B used to create doped pockets and security zones was described. This technology excludes thermal annealing and allows to create pockets and security zones simultaneously, which decreases the number of operations to ten and reduces the distance between the n and p transistors to 5.6 microns. Further, the characteristics of GaAs-based p+-n junctions were given, which allow to form complex structures with minimal defects, which in turn allows to create high-performance GaAs-based C-MOS transistors. Also, the paper considers the use of GaAs technology in solar cells, in which the charge carrier collection rate is increased by reducing the generation-recombination processes in the p-n junction, which greatly increases the efficiency of solar cells compared to monosilicon.

Keywords: multicharged ion implantation, gallium arsenide, CMOS technology, Schottky transistor, p+-n junction, graded band gap solar cell.

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THE STUDY OF MICROHETEROGENEOUS DISTRIBUTION OF ADMIXTURE IN SILICON MONOCRYSTALS (p. 41–47)

Ivan Chervony, Olga Golovko

We have analyzed the accumulation of admixture in the melt at the crystallization frontline in the process of growing silicon monocrystals and studied the model of accelerated crystallization of the melt area. The applied model of the admixture redistribution is as follows: when one layer of silicon crystallizes, one part of the admixture is absorbed by a growing crystal, while the other part remains in the melt and enriches its frontal area. When the second layer of silicon crystallizes, the growing crystal adsorbs the admixture from the admixture-enriched melt after crystallization of the first atomic layer, etc. Therefore, the melt frontal area experiences a stepwise accumulation of admixture and forms an area of the concentrate overcooling, which involves a possible growth of the concentrate to the critical value – there may occur an independent second phase.

According to calculations of the equation, the growth rate increases 5...7 times, which provides conditions for a saltatory change in the growth rate and crystallization of the admixture-enriched melt layer. After the saltatory crystallization, the frontline field repeats the admixture accumulation to a certain value and the mode of accelerated crystallization.

The strata characteristics can be eliminated or considerably reduced due to the proposed modes of growing single crystals at high velocities. The proposed technology prevents admixture accumulation at the crystallization frontline, and ensures its uniform distribution over a single crystal.

Keywords: silicon, crystallization front, single crystal/monocrystal, admixture, heterogeneity, strata, microcircuit, concentration, overcooling, phase.

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