DEVELOPMENT OF HEAT-MASS EXCHANGE OPTIMIZATION METHODS USING FRACTAL CONVOLUTIONS OF COMPUTER TOMOGRAMS (p. 4-9)

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It was shown that designing heat-mass exchange processes and devices requires the methods of non-destructive measurement of the real surface area of such an exchange. Since this surface is, usually, very complicated, convolutions of images obtained in the computer tomography were proposed. Tomograms of synthetic granite, confirming the technical feasibility of such analysis method and its informativeness in terms of further heterogeneous structure investigation were obtained.

Three types of convolutions: convolution in the form of Hausdorff dimensions of the section boundaries, convolution using contraction mapping and convolution using parabolic transformation were considered. The presence of a maximum on the dependence of the heat-mass exchange rate on the working surface convolution results, which allows to formulate and solve the problems of optimizing the parameters of technological processes and designs of heat-mass exchange devices was theoretically justified and experimentally confirmed.

Practical testing of the proposed optimization method in designing the packed absorber was performed. As a result of using the proposed method, an increase in the absorber performance by 16–23 % without increasing its size was achieved.

Keywords: heat-mass exchange, heat-mass exchange surface, heterogeneous flows, computer tomogram, fractal convolution.

References

INCREASING OPERATING DURABILITY OF FINE-SIZE TOOL BY THE METHOD OF LOW-TEMPERATURE ION IMPLANTATION (p. 10-13)

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The paper deals with increasing the operating durability of a fine-size tool. Applying this tool has economic benefits for producers since it leads to lower costs of the tool purchased. Using the method of low-temperature implantation, modified coatings of titanium and chromium nitride on tool steel substrates were obtained. Structure and physicomechanical properties of these coatings and their use as protective coatings on fine-size tools were investigated in the paper. Due to properly selected modes (U discharge=400 V, I discharge=0.5 a, U target=2 Q, Т target=50 mA, U substrate=25 kV, 35 mA=I substrate, r gas=3.32–10–2 Pa) introduced ion dose (5.73–1016–7.63–1017 ion/cm²), materials of the target (Ti and Cr) and substrate (R18 and HVG) as a result of experimental researches, high-quality protective coatings were produced, microhardness increased by 2.2–2.5 times. Practical use of research results has revealed an increase in operating durability of fine-size tool by 1.5–2 times. Applying ion-plasma treatment allows to produce steels with modified protective coatings and increase the operating durability of fine-size steel tools and small, but those that are key machine parts.

Keywords: ion implantation, titanium, chromium, modified coating, operating durability.
References


BASIC REGULARITIES OF THE FILTRATION DRYING OF WHEAT GRAIN (p. 14-18)
Iryna Matikivska, Volodymyr Atamanyuk, Dmitry Symak

This paper discusses the results of experimental investigations into the hydrodynamics and heat exchange specific to the filtration drying of wheat grain. The result of experimental investigations into the hydrodynamics has been generalized based on the inner problem, exterior problem and a mixed problem of hydrodynamics. The experimental data representations in the form of dimensionless numbers are easy-to-use in practice and enable determine the energy cost and the economic feasibility of the process. Determining the optimal parameters of filtration drying process was ensure by the investigation into heat exchange specificities and their generalization in the form of dimensionless numbers that would enable to compute the heat rejection factors, with the filtration modes and physical parameters of the heating medium being known. Obtained are the design dependences to determine the internal diffusion coefficients against the temperature of a heating medium and the initial moisture content of grains. The resulting design dependency may be used to predict the duration of the wheat grain filtration drying. Determined are the rational modes of drying for seed grain and food grain.

Keywords: wheat grains, moisture content, hydrodynamics, heat exchange, diffusion, drying kinetics.

References
about formation of stratum heterogeneity in the silicon single-crystals (p. 22-25)

Anna Iakymenko, Ivan Chervony

The analysis of the impurity accumulation in the melt at the crystallization front during the silicon single crystal growing was performed, and the model of rapid crystallization in this melt region was considered. The following impurity redistribution model was applied: during the crystallization of a single layer of silicon, one impurity part is absorbed by the growing crystal, while the other part remains in the melt, enriching its frontal area. During the crystallization of the second silicon layer, the growing crystal absorbs impurity from the impurity-enriched melt after crystallization of the first atomic layer, etc. Thus, in the frontal region of the melt, stepwise impurity accumulation and concentration supercooling region formation take place, including a possible increase in its concentration to the critical value – achieving the occurrence of independent second phase. According to calculations by the equation, growing rate increases by 3...7 times, and conditions for the abrupt change in the growing rate and crystallization of the impurity-enriched melt layer are ensured. After abrupt crystallization, the impurity accumulation to a certain value and accelerated crystallization mode are repeated in the frontal area. To eliminate or significantly reduce the strata characteristics, it is proposed to apply high-rate single crystal growing modes, which eliminates the impurity accumulation at the crystallization front and ensures its homogenous distribution by a single crystal growth.

Keywords: silicon, crystallization front, single crystal, impurity, heterogeneity, strata, chip, concentration, supercooling, phase.

References


Circuit, technological, physical and topological methods improve performance integral comparator (p. 25-33)

Stepan Novosyadlyy

Performance comparators defined as circuit solutions and technological and technological improvements. This article aims to study existing integrated comparators, which held copyright modernization circuitry, topologies and technologies that improve their performance at least 2 times, which determines the feasibility of the article.

As a result of investigations by the original Schematic technological solutions to improve performance integrated comparators.

Its input stage must have high attenuation of common mode component and the ability to withstand large common mode and differential input signals which are not saturating, i.e. not getting into profiles from which the comparator will go long.
A SIMULATION APPROACH TO STUDY OF ENTRIC ELASTICITY PROPERTIES OF POLYMER CHAIN MOLECULES USING ATOMIC SCALE MONTE-CARLO (p. 34-39)

Michael Grankin, Anatoliy Kargin, Eduard Karpov

This paper describes atomic scale Monte–Carlo studies of entropic elasticity properties of individual polymer chain molecules. An efficient numerical Monte–Carlo sampling approach is outlined and used to evaluate the entropic contribution to the total elastic force. Theoretic predictions of mechanical properties of polymer molecules, particularly complex bio-molecules (proteins, lipids, etc.), are difficult due to effects of entropic elasticity. Entropic elastic force can be a significant contributor to the free energy of the polymer chain and can even exceed interatomic potential energy under external mechanical load. Monte–Carlo based approach allows to achieve atomic resolution for molecular structure in contrast to analytical methods. Specific load-extension curves are obtained numerically for a group of molecules with degenerate potential energy profiles. Results of the atomistic modeling are compared with the limiting continuum model of the same type of polymers. The extent of the linear and nonlinear elastic regimes and dependence on the molecular weight and geometric parameters of the molecules are discussed. A significant divergence with the continuum model behavior is observed at smaller bond angles for all elongations of the molecule. Linearity of the entropic force exists in a wide range of the elongations, however, molecules with low gyration radii (densely packed polymers) are linear mostly in extension or unfolding, while very sparsely packed molecules are linear mostly in the contraction mode. The achieved result cannot be reproduced within the settings of the continuum model and required an application of atomic scale Monte-Carlo approach developed by our group.

Keywords: Monte-Carlo, model, simulation, entropy, elasticity, polymers, monomers, properties, radius, gyration.

References

THE EFFECT OF THE HEAT TREATMENT ON THE STRUCTURE AND PROPERTIES OF SINTERED TiC-TiNi, TiC-NiFe ALLOYS (p. 39-43)

Vladimir Pashynsky, Maria Subbotina

The features of heat treatment effect on the phase composition and crack resistance of sintered tool metastable-bunch alloys, hardened with TiC, were considered in the paper. Due to the fact that one of the major failure mechanisms of the tool, for the manufacture of which these alloys (forming rolls, bandages) were designed, is the crack network formation, the problem of decreasing brittleness of materials is of great scientific and practical value. Alloys with compositions 23% Ti-27% Ni and 39% Ti-11% Ni (+50% TiC); and as well as 19% Ni+46% Fe (+35% TiC) 10% Ni+40% Fe (+50% TiC) and 40% +10% Fe (+50% TiC) were considered. Crack resistance indicators of alloys along the length of the radial crack from hardness indentations in the as-sintered and asannealed condition at t=800...1100 °C were defined. It was shown that the reduction in crack resistance parameters provoke annealing at t=800-1000 °C for the alloy 19% Ni+46% Fe (+35% TiC), t=800 °C, 900 °C and 1100 °C for 40% Ni+10% Fe (+50% TiC), 1100 °C - 10% Ni+40% Fe (+50% TiC), respectively. This condition is accompanied by the presence of intermetallic compounds in the microstructure. The data obtained allow to recommend the use of alloys in the as-sintered condition, and avoid prolonged exposure of embrittlement temperatures during operation of products from them.

Keywords: powder alloy, titanium carbide, sintering, phase composition, brittleness, indentation.

References
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The experimental setup for measuring the specific electrical contact resistance (SECR) of solids contact pairs, depending on the compression pressure and temperature, has been developed.

In the development of graphitization furnaces numerical models the electrical properties of the contact interaction of copper-graphite, graphite-graphite, using a gasket of thermally expanded graphite, are important. Resistance of the contact portions is always greater than the contacting elements, thus, there are additional losses of energy in these regions. This affects the thermoelectric state of furnaces. The relevance of this study is determined by the absence of data concerning the contact resistance of graphite-graphite in the literature.

The most difficult task in the investigation of the contact resistance transition is to determine the actual contact area, the value of which depends on the nature of the microscopic bulge deformation. The theoretical solution to the problem concerning the actual contact area of real surfaces is very difficult, that is why experimental methods have become widespread in the study of the electrical solids contact resistance.

As a result of research, the following experimental data was observed: SECR of the copper-graphite at compression pressure of 1–7 MPa and under the temperature 16–25°C; SECR of the graphite-graphite at constant pressure of 1.7 MPa under the temperature range 16–250°C with subquadratic extrapolation to 3000°C.

The experimental data of the SECR contact pairs of copper-graphite and graphite-graphite-graphite is necessary for the priori estimation of graphitization furnace thermoelectric state during their development, modernization and also for electrothermoequipment of other industries.

**Keywords:** specific electric contact resistance, copper, graphite, thermo-expanded graphite, pressure, temperature.
of ceramic masses, production of ceramic clinker for various purposes using the plastic extrusion method.

Kaolin and pegmatite from the Khmelivskyi deposit that may act as fluxing agents were selected as kaoline-feldspar raw materials.

Methods of directed structure formation regulation of ceramic masses based on polymineral clay raw materials using kaoline-natural feldspar raw materials were investigated. Using mathematical planning, mathematical models of interaction and influence of various technological factors on the properties of experimental masses were developed. Using the correlation analysis method, the relationships in the system polymineral clay-kaoline-natural feldspar raw materials were examined.

Based on the ceramic mass 9 and 11 of the system polymineral clay-montmorillonite-substandard kaolin-pegmatite of the Khmelivskyi deposit, possibility to produce ceramic clinker by optimizing the chemical-mineralogical composition, and masses with a wide sintering interval was shown.

**Keywords:** structure formation, chemical-mineralogical composition, mathematical model, fusible clay, substandard kaolin, pegmatite, sintering interval, ceramic clinker, composition, properties.

**References**


**INFLUENCE OF GRINDING-POLISHING OF NATURAL STONE ON ITS SHINE AND LIGHTNESS SHADES (p. 56–60)**

**Volodymyr Shamray, Valentyn Korobiichuk**

An important problem of stone processing enterprises is decorativeness control of natural stone products. Among many different methods that allow to change natural stone decorativeness parameters, textured surface finishing is the most common. In the study of products from Pokostivske granodiorite, color and lightness classification was proposed. Depending on the stone surface roughness, a change in the stone lightness and shine was investigated. Using the fine-grained diamond tool, stone sample darkening is achieved by reducing the stone surface roughness. Stone lightness can be adjusted to ensure minimum differences in their future use. Ensuring minimum differences of the polished stone surface is possible for species with the same color and adjusted for a stone with red and blue color (from light to dark); for a stone with blue color (from dark to very dark). In the future, it is important to solve the problem of labeling different types of blocks that will ensure their recognition and selection of the grinding-polishing procedure to provide the desired lightness shade.

**Keywords:** stone lightness, Pokostivske granodiorite, grinding-polishing, stone glitter, stone color, stone surface roughness.

**References**


**ANALYSIS OF IMPACT OF LEIKONAT HARDENER AND MICROWAVE ENERGY ON THE ADHESIVE JOINT STRENGTH (p. 61–65)**

**Olesya Medvid, Valentyna Oliynykova, Lydmila Svistunova**

A new polychloroprene adhesive composition with increased adhesion strength for gluing bottom parts of footwear was theoretically developed and practically created. The dependence of its holding strength on the content of fillers: modified kaolin, diphenyl guanidine, carbon black DG-100 and leikonat hardener and its benefits in terms of physico-chemical and chemical indicators was proved.

As a result of the research, an increase in the adhesion strength of polychloroprene adhesives for footwear manufacture was achieved. The main components of the polychloroprene adhesive composition are nairit NT, gasoline BR1 or BR2, ethyl acetate of the grade A, modified kaolin, diphenyl guanidine, carbon black DG-100 and leikonat. Adding 5 % leikonat and microwave energy irradiation increases adhesion strength by 59 %. Modified adhesive composition can be recommended for the manufacture of special footwear.

The technological standards and modes of assembly of uppers and footwear using microwave energy and modified adhesives in the footwear industry to improve the physico-chemical properties of ready shoes were determined.
Keywords: polychloroprene, adhesive composition, leyconate, microwave energy, adhesion strength, ethyl acetate, hardener, adhesion.

References