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**V.S. BORMASHOV, A.V. GOLOVANOV, A.P. VOLKOV, S.A. TARELKIN, S.G. BUGA, V.D. BLANK
DEEP REACTIVE ION ETCHING OF SYNTHETIC DIAMOND**

In this work the deep reactive ion etching process of monocrystalline synthetic diamond surface was developed and studied. The process consisted of two alternating steps: etching in SF₆ - based plasma and protective film deposition in CF₄ - based plasma. To control the relief of the surfaces of diamond samples before and after etching, the frequency dependence of power spectrum density of the roughness of atomic force microscopy experimental images was analyzed at different spatial scales.

Key words: reactive ion etching, synthetic diamond, atomic force microscopy, roughness power spectral density

**T.V. ERSHOVA, T.F. YUDINA, I.V. BRATKOV, N.N. SMIRNOV, N.Yu. BEIYLINA, E.P. MAYANOV
EFFECT OF GRAPHENE OXIDE NANOPARTICLES ON MORFOLOGY OF SURFACE
OF COMPOSITE ELECTROCHEMICAL COATINGS WITH ZINC MATRIX**

Effect of disperse phase (DPH) on the morphology of the surface of composite electrochemical coatings (CEChC) on the zinc matrix with grapheme oxide nano particles was studied.

Key words: composite electrochemical coatings, grapheme oxide nanoparticles, surface morphology

**T.F. YUDINA, I.V. BRATKOV, T.V. ERSHOVA, N.N. SMIRNOV, N.Yu. BEIYLINA, E.P. MAYANOV
CONDITION OPTIMIZATION OF NATURAL GRAPHITE OXIDATION**

Influence of graphite bisulfate steam-air treatment on properties of oxidized and thermally-expanded graphite was considered. Steam-air treatment was established to result in the increase in intercalates content, the rising of heat efficiency of intercalates decomposition and essential decrease in thermally-expanded graphite bulk density.

Key words: oxidized graphite, thermally-expanded graphite

**S.A. URVANOV, Yu.L. AL'SHEVSKY, M.A. KHASKOV, A.R. KARAEVA,
V.Z. MORDKOVICH, D.N. CHERNENKO****STUDY OF MECHANICAL PROPERTIES OF CARBON FIBERS MODIFIED WITH FULLERENES**

Data on fullerene modification of carbon fibers are presented. This carbon coating was studied with scanning electron microscopy and Raman spectroscopy. The modification influence on mechanical properties of composite based on carbon fibers was studied. The increase in tensile strength of monofilament was discovered with respect to the initial carbon fiber.

Key words: carbon fiber, fullerene, composites

**B.P. SOROKIN, G.M. KVASHNIN, V.S. BORMASHOV, A.P. VOLKOV, A.V. TELICHKO,
G.I. GORDEEV, A.V. GOLOVANOV****TECHNOLOGY OF MANUFACTURING PIEZOELECTRIC AlN FILM TRANSDUCER
ON SUBSTRATE OF SYNTHETIC DIAMOND SINGLE CRYSTAL**

Magnetron sputtering technology of a piezoelectric films from aluminum nitride (AlN) and metal electrodes on a substrate of single crystal synthetic diamond was developed. To create the electrode structures with a given topology the standard and explosive photolithography methods were used. The structure of the films was studied by X-ray diffraction, atomic force and scanning electron microcopies.

Key words: piezoelectric film of AlN; synthetic diamond single crystal; magnetron sputtering

N.N. SMIRNOV, T.F. YUDINA, T.V. ERSHOVA, I.V. BRATKOV, N.Yu. BEIYLINA
FEATURES OF GRAPHITE MECHANOCHEMICAL OXIDATION

The influence of conditions of intensive mechanical actions on the graphite oxidation rate in air was studied. The features of mechanical oxidation were considered on the base of X-ray diffraction data and simultaneous thermal analysis of coke. The influence of composition of the gas mixture on chemical composition of the oxidation products was shown.

Key words: mechano-chemistry, activation, graphite oxidation, intercalation, coke, mechano-chemical modification

A.V. NASIBULIN, A.V. PETROV, N.Yu. BEIYLINA, G.S. DOGADIN
**STUDY OF INFLUENCE OF INPUT METHOD OF NANO-STRUCTURING ADDITIVE
ON PITCH MATRIX PROPERTIES**

Carbon constructional materials are widely used in various industries. A steady increase in performance requirements leads to the search for new modifying components. Using nano-additives showed a significant improvement in the performance of many construction materials. However, the use of nano tubes in composites has difficulties, in particular, the complexity of uniform distribution of the additive in the body of the composite. This article provides an overview of the methods of distribution of additives in the material volume.

Key words: coal pitch, carbon nano tube, modification

K.S. KRAVCHUK, A.S. USEIYNOV
**METHODS OF DETERMINATION OF FRACTURE STRENGTH OF THIN DIAMOND-LIKE
COATINGS BY DIAMOND INDENTER**

Tests of diamond-like coating were carried out by methods of instrumented indentation and scratch tests for determination of conditions of cracks formation of various types. The comparison of different methods of fracture strength calculation was done. The recommendations on measurement modes choice were given for thin diamond-like coatings.

Key words: diamond-like coatings, thin films, breaking viscosity, indentation, sclerometry

T.A. IVANOVA, B.N. MAVRIN
**FIRST-PRINCIPLE INVESTIGATIONS OF STRUCTURAL, ELASTIC AND VIBRATIONAL
PROPERTIES OF DIAMOND HEXAGONAL POLYTYPES**

In the density functional theory approximation we calculated primitive cells parameters, bond lengths, elastic constants c_{ij} and s_{ij} , the elastic modules B, G and E, hardness, phonon dispersion and density of vibrational states in the diamond hexagonal polytypes 2H, 4H, 6H and 8H. We also investigated the anisotropy of the elastic modules and hardness. It was shown that the difference of anisotropic properties along and perpendicular to the hexagonal axis may be related to the polytypes structure. From the assessment of interactions between bilayers of carbon atoms in the polytypes structure it was assumed that the main mechanism of disproportionation of crystal is competing interaction between bilayers.

Key words: diamond, hexagonal polytypes, elastic modules, hardness, states phonon density, vibration spectra

A.E. GRISHTAEVA, I.A. PEREZHOGIN, B.A. KULNITSKIY, S.A. PERFILOV, R.L. LOMAKIN, V.D. BLANK
TEM STUDIES OF W-C₆₀ SYSTEM

The sample under study was prepared from powders of tungsten and fullerene by ball milling and subsequent sintering by the electric current pulse. Transmission electron microscopy studies have shown that after the sintering the tungsten sample is mainly presented as the carbide WC. It was found that fast but short-time heating to high temperatures after milling of the powder results in the appearance of stacking faults in the {100} planes of the tungsten carbide particles.

Key words: tungsten, fullerene, transmission electron microscopy, tungsten carbide, sintering by electric current pulse

D.B. VERBETS, L.M. BUCHEV, Z.V. AISMONT, D.V. SERGEEV, V.M. SAMOYILOV
**INFLUENCE OF TREATMENT TEMPERATURE IN 900–3200°C RANGE ON STRENGTH
AND ELASTIC MODULUS OF POLYACRYLONITRILE-BASED CARBON FIBERS**

In given article some methods of improvement of strength properties of carbon fibers on the base of home PAN-precursors by means of correction of carbonization condition.

Key words: carbonization, carbon fibers, filaments, strength, elasticity modulus, elementary fibers, deformation, PAN-precursor

D.N. CHERNENKO, N.Yu. BEIYLINA, N.M. CHERNENKO

INFLUENCE OF PRELIMINARY FINISHING OF INITIAL RAYON FILAMENTS ON STRENGTH OF GRAPHITE FIBERS AND CHANGE OF PROPERTIES OF CARBON FIBERS UNDER HIGH TEMPERATURE TREATMENT

This article is devoted to the research of influence of preliminary finishing of rayon filaments on strength of graphite fibers and changes in the properties of carbon fibers depending on the conditions of obtaining the carbonized fibers based on rayon fibers obtained by the viscose method which are undergone by high temperature treatment.

Key words: rayon viscose fibers, carbon fibers, carbonization, graphitization, thermochemical conversion, relaxation, catalyst

D.V. TETERUK, S.A. TARELKIN, V.S. BORMASHOV, A.P. VOLKOV, N.V. KORNILOV, S.A. TARENT'EV **DOPING OF CVD DIAMOND**

Study of the processes and methods of doping CVD diamond is one of the most urgent tasks of diamond electronics today. Understanding the nature of diamond doping is necessary to improve electronic properties of diamond and use it as a semiconductor material in microelectronics. This paper presents results of the study of boron and nitrogen doping of diamond and new methods of doping diamond. The results of the dopants concentration measurements and electronic properties of the obtained diamond layers are presented.

Key words: diamond, CVD, doping

D.N. SMIRNOVA, N.N. SMIRNOV, T.F. YUDINA, N.Yu. BEIYLINA, P.G. ELIZAROV **SILICON-CARBON ADSORBENT FOR PURIFICATION OF EXTRACTION PHOSPHORIC ACID AND EXTRACTING FROM IT RARE EARTH ELEMENTS**

Extraction phosphoric acid is a multicomponent product. Using sorbents for acid purification and removal from it rare earth elements (REE) is actuality today. Mechanochemical synthesis of carbon adsorbent using the silica with different activity was considered. At mechanochemical activation the compounds of carbide and silicon oxycarbide are formed. It was shown that at extraction phosphoric acid purification on obtained oxycarbon adsorbents the degree of defluorination is increased with REE adsorption on the adsorbent surface.

Key words: phosphoric acid, rare earth element, carbon adsorbent, silica, mechanical activation

I.V. PAKHOMOV, N.R. SEREBRYANAYA, R.Kh. BAGRAMOV, V.M. PROKHOROV, K.S. KRAVCHUK **SYNTHESIS OF SUPERHARD COMPOSITE MATERIALS IN C₆₀-DIAMOND SYSTEM AT HIGH PRESSURES AND TEMPERATURES**

For the first time the samples of diamond composites with a matrix of polymerized C₆₀ were obtained by thermobaric treatment. The structure of the obtained materials was studied by optical microscopy and X-ray analysis. Thermophysical properties were analyzed depending on the ratio of the proportion of diamond particles in a matrix of composite. The hardness and wear resistance of these samples are comparable with similar properties of diamond drilling tools.

Key words: fullerite, super hard composite material, high pressures and temperatures, wear resistance

I.I. MASLENIKOV, A.S. USEINOV **DETERMINATION OF POSSIBILITY OF AFM FOR DETERMINATION OF MECHANICAL PROPERTIES OF THIN COATINGS**

Hardness and elastic modulus of diamond-like coatings on silicon and platinum on silicon were obtained. Corresponding relations between mechanical characteristic of system and radius of contact were treated with the help of different models. These calculations were used to determine the hardness and elastic modulus for material of coatings. Elastic modulus of each coating was also determined with the help of force spectroscopy method.

Key words: nano indentation, thin coatings, hardness, Young's modulus

A.G. KVASHNIN, Yu.A. KVASHNINA, L.Yu. ANTIPINA, O.P. KVASHNINA, T.P. SOROKINA, P.B. SOROKIN **PHASE TRANSITIONS IN QUASI-TWO-DIMENSIONAL CARBON MATERIALS**

The stability of the diamond films with (111) and (110) crystallographic orientations of the surface was investigated using the method of density functional theory. Phase diagram for the transition from multilayered

graphene into diamond film was obtained as a function of the film thickness and surface type (pure or hydrogenated ones). We show that chemically induced phase transition changes significantly the transformation process of multilayered graphene to diamond film. For the first time, the atomic structure, stability and phase diagram were obtained for the diamond films with (110) crystallographic orientations of the surface.

Key words: DFT, graphene, graphane, diamane, ultrathin diamond film, phase transitions

M.I. ZHARCHENKOVA, S.A. PERFILOV, R.L. LOMAKIN

STUDY OF PHYSICAL AND MECHANICAL PROPERTIES OF NANOSTRUCTURED TUNGSTEN MODIFIED BY CARBON NANOCCLUSERS

In this work the physical and mechanical properties of nanostructured tungsten with carbon nanoclusters (fullerenes and nanodiamonds) were studied. Samples of the W powders and mixtures with carbon nanocomposites were sintered at high pressures and temperatures. During sintering under pressure the use of nanoscale powders and modification by carbon nanocomposites leads to the increase in the physical and mechanical properties of the sintered tungsten.

Key words: nanostructuring, sintering under pressure, tungsten, fullerene, nano diamond, refractory solid materials

D.G. KVASHNIN, P.B. SOROKIN, O.P. KVASHNINA, T.P. SOROKINA, L.A. CHERNOZATONSKIY
INVESTIGATION OF NOVEL CARBON NANOSTRUCTURES BASED ON TWO LAYER GRAPHENE WITH PERIODICALLY ARRANGED HOLES

Study of the atomic structure, stability and energy barrier of transformation from two layer graphene with periodically arranged holes to novel carbon nanostructure was carry out using density functional theory. The presence of the holes in the two layer graphene surface was shown to result in the connections between the layers without energy barrier. Obtained results have a good agreement with experimental data.

Key words: DFT, graphene, two layer graphene

G.M. STROGAYA, T.F. YUDINA, T.V. ERSHOVA, N.Yu. BEIYLINA, A.K. KRIVTSOV
CHEMICAL NICEL PLATING OF SYNTHETIC DIAMOND

Chemical nickel plating of synthetic diamonds without using the treatment in the solutions of tin and palladium salts was studied. The action of preliminary preparation in a number of solutions and plasma treatment before diamond activation on the rate of nickel plating and the deposit quality was revealed. It was proposed to add into a nickel plating solution an additive which belongs to a group of naphthalene sulphonates. It allows to accelerate a metal reduction and to deposit the slight tension nickel coating.

Key words: chemical nickel plating, synthetic diamonds, metallization, nickel reduction

D.B. VERBETS, V.M. SAMOIYLOV, Yu. Z. KARASYOV, Yu. A. MALININA, L.M. BUCHNEV
STUDY OF PHYSICAL-CHEMICAL PARAMETERS OF OXIDIZED PAN FIBERS AND THEIR INTERRALATION WITH STRENGTH OF CARBON FIBERS

In given article the results of studies of PAN precursors of high-strength carbon fibers were described. The results of studies of IR spectra and thermo gravimetric analysis were presented for PAN-precursor of dimethyl formamide method of formation of double co-polymer composition and dimethyl sulfoxide method of formation of precursors of triple co-polymer composition on different steps of their treatment to carbon fibers. Therresults obtained were compared with strength and with modulus of elasticity of obtained carbon fibers.

Key words: oxidation, IR spectroscopy, PAN precursor, carbonization, carbon fibers, filaments, strength, modulus of elasticity