

CONTENTS

Blank V.D.

Conference of young scientists of ural region «Participation of young scientists in fundamental, searching and applying studies on creation of new carbon and nano carbon materials» 3

Kvashnin A.G., Sorokin P.B.

Study of the phase transitions features in ultrathin diamonds 4

Dokuchaev A.G., Bushuev V.M., Shchurik A.G., Sokolkin Yu.V.

Effect of pyrocarbon coatings of thin-walled carbon-carbon composites on their siliconizing degree 7

Sorokin O.Yu., Bubnenkov I.A., Koshelev Yu.I., Orekhov T.V.

Development of fine grain siliconized graphite with improved properties 12

Khorkov K.S., Gerke M.N., Prokoshev V.G., Arakelyan S.M.

Formation of carbon thin films under action of femtosecond laser radiation in vacuum..... 17

Karaeva A.R., Mordkovich V.Z., Khaskov M.A., Mitberg E.B., Kulnitskiy B.A., Kirichenko A.N.,

Denisov V.N., Perezhugin I.A.

Catalytic growth of carbon nanotubes in presence of water vapor 20

Bagramov R.Kh., Pakhomov I.V., Serebryanaya N.R., Dubitskiy G.A., Polyakov E.V., Blank V.D.

Research of structure and properties of material with onion-like structure synthesized from fullerite C₇₀ 25

Yudina T.F., Ershova T.V., Beiyliina N.Yu., Smirnov N.N., Bratkov I.V., Shchennikov D.V.

Mechanochemical activation of graphite materials 29

Yudina T.F., Strogaya G.M., Ershova T.V., Susova L.L., Beiyliina N.Yu.

Chemical metallization of carbon materials of developed surface 34

Blank V.D., Golubev A.A., Gorbachev V.A., Deribas A.A., Dubitskiy G.A., Serebryanaya N.R.,

Shevchenko N.V.

Detonation synthesis of microdiamonds 37

Krasnikova O.V., Andreiykov E.I., Dikovinkina Yu.A.

Carbonization of coal tar and petroleum pitches modified by heat treatment with polystyrene..... 41

Tolbin A.Yu., Nashchokin A.V., Kepman A.V., Malakho A.P., Sorokina N.E., Avdeev V.V.

Influence of surface modification of reinforcing filler with carbon nanostructures on adhesive strength of interconnection fiber – epoxy binder 44

Trubin F.V., Dokuchaev A.G., Chunaev V.Yu.

Research of influence of high temperature treatment on properties of carbon-carbon composite materials for vapor siliconizing 48

Fazlitdinova A.G., Tyumentsev V.A.

Structural and chemical transformation of polyacrylonitrile fiber material during thermomechanical treatment..... 51

Petrov A.V., Cheblakova E.G., Beylina N.Yu.

Some aspects of mechanism of sulfur removal in process of coking virgin oil feedstock in presence of carbon additives 55

Ganziy D.A., Kravchuc K.S., Maslenikov I.I., Prokudin S.V.

Investigation of local electrical properties and phase transitions with nanoindentation method..... 59

Bushuev V.M., Sinani I.L., Butuzov S.E.	
Application prospects of siliconizing process for manufacturing carbon/silicon-carbide composite large-size hermetic constructions	63
Bushuev V.M., Vorob'yov A.S., Shchurik A.G., Sinani I.L., Bushuev M.V.	
Dependence of efficiency of alternative liquid-phase siliconizing carbon-carbon composite material on reactor pressure.....	67
Bormashov V.S., Volkov A.P., Golovanov A.V., Tarelkin S.A., Buga S.G., Blank V.D.	
Reactive ion etching of synthetic monocrystalline diamond surface in plasma	71

A B S T R A C T S

*A.G. KVASHNIN, P.B. SOROKIN***STUDY OF THE PHASE TRANSITIONS FEATURES IN ULTRATHIN DIAMONDS**

The atomic structure and physical properties of diamond films of nano-scale thickness of (111) oriented surface was studied. The stability of the clean films and films with surface covered by hydrogen passivating layer was studied with the density function theory. The phase transition process «multilayer graphene to diamond film» was investigated. The phase transition pressure was shown to depend upon the thickness of the structure. Obtained results agree well with available experimental data.

Key words: DFT, graphene, diamane, phase transitions

*A.G. DOKUCHAEV, V.M. BUSHUEV, A.G. SHCHURIK, Yu.V. SOKOLKIN***EFFECT OF PYROCARBON COATINGS OF THIN-WALLED CARBON-CARBON COMPOSITES ON THEIR SILICONIZING DEGREE**

The results of studies on vapor-phase siliconizing of thin plates of carbon-silicon carbide materials (CSCM) of 2D+1 structure having pyrocarbon coating of various thickness was described. The increase in CSCM density and pyrocarbon coating thickness leads to the decrease in silicon content. Silicon content in C/C-SiC CM not exceed 13 mass %, if pyrocarbon coating thickness and CSCM density is more than 2 μm and 1.53 g/cm^3 , respectively. Close tensile and bending strength values of initial CSCM and obtained CSCM is evident of keeping the carbon fibers skeleton after siliconizing.

Key words: carbon-carbon composite material, pyrocarbon, siliconizing, C/SiC composite material, strength

*O.Yu. SOROKIN, I.A. BUBNENKOV, Yu.I. KOSHELEV, T.V. OREKHOV***DEVELOPMENT OF FINE GRAIN SILICONIZED GRAPHITE WITH IMPROVED PROPERTIES**

The main technological difficulties connected with the creation of perspective material-fine grain siliconized graphite- are considered. Careful selection of carbon filler and creation of optimal porous structure for its impregnation with the melt of liquid silicon was shown to allow creating carbon-carbide-silicon material exceeding on their parameters the siliconized graphites existing in Russia. These materials are inferior to world analogies.

Key words: siliconized graphite, impregnation, porous carbon base, reactivity, carbide formation

*K.S. KHORKOV, M.N. GERKE, V.G. PROKOSHEV, S.M. ARAKELYAN***FORMATION OF CARBON THIN FILMS UNDER ACTION OF FEMTOSECOND LASER RADIATION IN VACUUM**

In given work the obtaining the thin-film carbon coatings with the laser ablation method of glass-carbon in vacuum of 10^{-4} Torr was considered. Sputtering results at Yb:KGW laser system application were shown. The laser system had the following parameters: the central wavelength is 1030 nm, the pulse repetition rate is 10 kHz, pulse duration is 280 fs, the pulse energy is 150 μJ and diameter of the focused spot is about 50 microns.

Key words: laser ablation, ultrafast laser pulses, nanostructures, glass-carbon, diamond-like films

*A.R. KARAEVA, V.Z. MORDKOVICH, M.A. KHASKOV, E.B. MITBERG, B.A. KULNITSKIY,
A.N. KIRICHENKO, V.N. DENISOV, I.A. PEREZHOGIN***CATALYTIC GROWTH OF CARBON NANOTUBES IN PRESENCE OF WATER VAPOR**

One of the most important problem in the synthesis of carbon nanotubes is the control of their morphology, namely: length, aspect ratio, relative orientation, etc. Catalytic synthesis of carbon nano tubes in a

suspension layer allowed to study the possibilities of control with the growth of nanotubes by introducing a certain amount of water vapor and carbon-containing materials in the reaction zone. The synthesized long carbon nanotubes were studied by Raman spectroscopy, transmission and scanning electron microscopy.

Key words: carbon nano tubes, synthesis, catalysis, electron microscopy

**R.Kh. BAGRAMOV, I.V. PAKHOMOV, N.R. SEREBRYANAYA, G.A. DUBITSKIY, E.V. POLYAKOV,
V.D. BLANK**

**RESEARCH OF STRUCTURE AND PROPERTIES OF MATERIAL WITH ONION-LIKE
STRUCTURE SYNTHESIZED FROM FULLERITE C₇₀**

The fullerite C₇₀ transformation to nano carbon with onion structure was discovered in gas-state in nitrogen medium. Onion structure presented curved fragmented carbon layers containing nitrogen. At conditions of high static pressure of 7.7 GPa and temperature of 1350 °C the onion structure is preserved. The studies of structure and properties of this material were carried out.

Key words: fullerite C₇₀, nano carbon, onion-like structure, high pressures and temperatures, X-ray diffraction, elastic recovery

**T.F. YUDINA, T.V. ERSHOVA, N.Yu. BEIYLINA, N.N. SMIRNOV, I.V. BRATKOV,
D.V. SHCHENNIKOV**

MECHANOCHEMICAL ACTIVATION OF GRAPHITE MATERIALS

The influence of mechanochemical activation of lamellar graphite of GSM-1 trade mark on surface properties was studied. The mechanochemical treatment was established to results in formation on the surface a lot of acidic active sites, the nature and concentration of which acts strongly on graphite materials chemical behavior.

Key words: mechanochemical activation, surface functional groups, lamellar graphite

**T.F. YUDINA, G.M. STROGAYA, T.V. ERSHOVA, L.L. SUSOVA, N.Yu. BEIYLINA
CHEMICAL METALLIZATION OF CARBON MATERIALS OF DEVELOPED SURFACE**

Long-term studies of metals chemical reduction (copper, nickel and others, and their alloys) from their salt solution on the materials with developed surface, including powder materials were summarized. The possibility of metallization process realization was shown under different variants of surface powder treatment allowing avoiding the activation in salt solution of tin, palladium and silver. The surface treatment method was revealed to influences on phosphorus content in Ni-P coatings.

Key words: metal chemical reduction, powder-like materials, graphite

**V.D. BLANK, A.A. GOLUBEV, V.A. GORBACHEV, A.A. DERIBAS, G.A. DUBITSKIY,
N.R. SEREBRYANAYA, N.V. SHEVCHENKO**

DETONATION SYNTHESIS OF MICRODIAMONDS

The parameters and properties of diamond micro crystals obtained with the detonation synthesis in explosive camera were studied. The synthesis of micro dimension-diamond-powders was carried out in a water medium at the use of trinitrotoluene as an explosive material.

Key words: detonation synthesis, carbon, micro diamonds, powders, high explosive, X-ray, Raman scattering, diamond compacts

**O.V. KRASNIKOVA, E.I. ANDREIYKOV, Yu.A. DIKOVINKINA
CARBONIZATION OF COAL TAR AND PETROLEUM PITCHES MODIFIED
BY HEAT TREATMENT WITH POLYSTYRENE**

In this paper, the carbonization process of coal-tar and petroleum pitches modified by heat treatment with polystyrene was studied by means of gravimetric method and optical microscopy one.

Key words: carbonization, heat treatment, coal-tar pitch, petroleum pitch, polystyrene

**A.Yu. TOLBIN, A.V. NASHCHOKIN, A.V. KEPMAN, A.P. MALAKHO, N.E. SOROKINA, V.V. AVDEEV
INFLUENCE OF SURFACE MODIFICATION OF REINFORCING FILLER WITH CARBON NANO-
STRUCTURES ON ADHESIVE STRENGTH OF INTERCONNECTION FIBER – EPOXY BINDER**

The method for carbon fiber surface modification by carbon nanostructures using the chemical deposition from a vapor mixture of benzene and cyclohexane in the temperature range of 600÷900°C was considered.

The influence of carbon fibers surface modification on the strength of the adhesive interaction between the fiber and an epoxy matrix was studied applying the polarization-optical technique. The interlayer shear strength was established to increase in the whole temperature range as compared to untreated fiber

Key words: carbon nanostructures, carbon fiber, polarization-optical technique, adhesive shear strength

F.V. TRUBIN, A.G. DOKUCHAEV, V.Yu. CHUNAEV

RESEARCH OF INFLUENCE OF HIGH TEMPERATURE TREATMENT ON PROPERTIES OF CARBON-CARBON COMPOSITE MATERIALS FOR VAPOR SILICONIZING

In given article the influence of the processes of high temperature treatment on carbon-carbon composite materials is considered. The effect of high temperature treatment on mechanical strength of carbon-carbon composite materials and ability to nonreversible deformations was studied.

Key words: composite materials, carbon fibers, mechanical strength

A.G. FAZLITDINOVA, V.A. TYUMENTSEV

STRUCTURAL AND CHEMICAL TRANSFORMATION OF POLYACRYLONITRILE FIBER MATERIAL DURING THERMOMECHANICAL TREATMENT

The changes in average dimensions L of coherent-scattering regions and texture of polyacrylonitrile (PAN) fiber during isothermal thermo mechanical treatment, the influence of temperature and tensile load on this process were considered by X-ray diffraction. The change in average coherent-scattering region dimensions was shown to depend on oriented angle to the fiber axis direction. The phase transformation of the thermo stabilized fiber proceeds via the formation of a new high dispersed phase in local micro volumes. The increase in the number of such local micro volumes is accompanied by gradual fragmentation of coherent-scattering regions and the break in the texture of polyacrylonitrile.

Key words: polyacrylonitrile fibers, thermo stabilization, texture, coherent-scattering region

A.V. PETROV, E.G. CHEBLAKOVA, N.Yu. BEYLINA

SOME ASPECTS OF MECHANISM OF SULFUR REMOVAL IN PROCESS OF COKING VIRGIN OIL FEEDSTOCK IN PRESENCE OF CARBON ADDITIVES

The effect of fine-dispersed particles of carbon additives to the goudron on content of sulfur, vanadium and nickel in forming from it the coke were studied. The goudron modification with carbon additives was shown to allow decreasing the content of sulfur, vanadium and nickel in coke on 29%, 56% and 65%, respectively. The dependences of various characteristics of the coking process and the properties of the coke on content additives were revealed to be extreme that is consistent with the states of the theory of petroleum disperse systems.

Key words: coke, goudron, modification, carbon additives, sulfur, vanadium, nickel, petroleum disperse systems

D.A. GANZIY, K.S. KRAVCHUC, I.I. MASLENIKOV, S.V. PROKUDIN

INVESTIGATION OF LOCAL ELECTRICAL PROPERTIES AND PHASE TRANSITIONS WITH NANOINDENTATION METHOD

The analytical model of plastic interaction between electrically conductive indenter and sample is presented. Experiments conducted on scanning nano-hardness testers «NanoScan» and probe nanolaboratory «NTEGRA» equipped with boron-doped diamond single crystal confirmed the theoretical model. A change in current value was shown to give additional information on indenter-sample interaction. The influence of contact area and specific resistance changes occurring at phase transition in silicon on measuring value of voltage is discussed.

Key words: scanning probe microscopy, nano indentation, boron-doped diamond single crystal, electrical contact, spreading resistance, piezoresonance probe, phase transition, silicon, mechanical properties, electrical properties

V.M. BUSHUEV, I.L. SINANI, S.E. BUTUZOV

APPLICATION PROSPECTS OF SILICONIZING PROCESS FOR MANUFACTURING CARBON/SILICON-CARBIDE COMPOSITE LARGE-SIZE HERMETIC CONSTRUCTIONS

The possibility of different siliconizing methods of application to manufacturing carbon/silicon-carbide composite large-size hermetic details is analyzed. The most acceptable siliconizing method for this purpose was shown to be the vapor-liquid-phase one.

Key words: hermetic details, vapor-liquid-phase siliconizing

**V.M. BUSHUEV, A.S. VOROB'YOV, A.G. SHCHURIK, I.L. SINANI, M.V. BUSHUEV
DEPENDENCE OF EFFICIENCY OF ALTERNATIVE LIQUID-PHASE SILICONIZING
CARBON-CARBON COMPOSITE MATERIAL ON REACTOR PRESSURE**

The liquid-phase siliconizing at silicon nitride heating was studied. The decomposition temperature of silicon nitride is decreased at low pressure in reactor. At conditions of quasi closed volume in experimental reactor the heating rate of samples and silicon nitride was increased in the range of 1300 – 1650 °C. Due to the decrease of contact time of silicon nitride particles and carbon containing gases of reaction zone the smooth carbide-silicon coatings were deposited on thin-wall details from carbon-carbide-silicon materials. For the large scale reactor the conditions of quasi-closing are disturbed and quality of carbide coatings becomes worse.

Key words: carbon-carbon composites, silicon nitride, silicon carbide, pressure, heating rate

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

The effect of reactive ion etching on synthetic HPHT mono crystalline diamond using Ar/O₂ plasma was studied. The plasma treatment was shown can to result in the smoothing diamond surface. The reduction of root-mean-squared roughness from 4.6 to 3.7 nm for a 10 μm × 10 μm scanned area was achieved. The surface topography and profiles were characterized by atomic force microscopy (AFM) at different spatial scales.

Key words: reactive ion etching, synthetic diamond, post mechanical polishing, atomic force microscopy