

A B S T R A C T S

*V.I. ZUBOV***THIRD, MOLECULAR FORM OF CARBON – FULLERENES, FULLERITES AND FULLERIDES. PRE-HISTORY, DISCOVERY AND PHYSICAL PROPERTIES**

A brief review on the pre-history and discovery of fullerenes (and later carbon nanotubes), which are the third molecular form of carbon and various, mainly physical, properties of the fullerites, i.e. crystals composed from fullerene molecules is given. The main attention attends to intermolecular forces, especially in the orientation- disordered phases. The Girifalko potential has been presented for eight fullerites from C_{28} to C_{96} and its generalization has been made for the interactions between the molecules of different fullerenes, C_m and C_n . Thermodynamic properties of high temperature modifications of fullerite families from C_{36} to C_{96} calculated in equilibrium with their saturated vapor are discussed on the base of correlation method of non- symmetrized self-consistent field which allow to take into account the strong anharmonicity of crystal lattice vibrations. The calculations have been performed up to temperatures of stability loss (spinodal points) T_s . The results have been compared with available experimental data. Behavior of some characteristics is considered depending on the number of atoms in a molecule. Using the Lindemann melting criterion the possible melting curve of the C_{60} fullerite has been estimated.

Key words: fullerene, carbon nano tubes, graphite, fullerite, fulleride, phase transition

*V.D. BLANK, M.Ya. KATSAY***MODERN PRESENTATION OF PHASE DIAGRAMS FOR MACRO- AND NANOCARBON**

On the base of analysis and generalization of experimental data on abnormal change of graphite physical properties with the temperature increase and on determination of triple point parameters for graphite-liquid-vapor published after 1994 year the phase diagram for bulk carbon in the field of high pressures and temperatures has been presented. That diagram agrees with the stability area of carbine. The phase P,T,d-diagrams for nano carbon with the cluster size of 5 and 2 nm have been calculated. The reaction P,T-areas of transformation of graphite, fullerite C_{60} , amorphous carbon and carbine to diamond have been determined.

Key words: phase diagram, carbon, graphite, diamond, carbine, fullerene, lonsdaleite, glass carbon

*O.A. SHENDEROVA, I.S. LARIONOVA, S.C. HENS***MODERN NANODIAMONDS OF DYNAMIC SYNTHESIS FOR BIOTECHNOLOGICAL AND MEDICAL APPLICATIONS**

Requirements for nano scale diamonds from point of view their biomedical applications are considered. Classes of nano diamonds currently used in biotechnology and nano medical researches are discussed, as well as perspectives and possibilities of achievement of required properties for nano diamonds of dynamic synthesis are considered.

Key words: nano diamonds, dynamic synthesis, bio technology, bio materials, photoluminescence, bio markers, sorbents, bio active substances, NMR, detonating synthesis, crystallite, functional groups

A.D. RUD, L.I. IVASHCHUK, N.I. KUSKOVA, G.M. ZELINSKAYA, V.N. UVAROV, E.E. MELNICHUK
STRUCTURE OF AMORPHOUS CARBON PRODUCED BY ELECTRIC BREAKDOWN OF HYDROCARBON LIQUIDS

The type of short-range order of amorphous carbon produced by a technology of high-energy electric discharge treatment of different organic liquids (kerosene, benzene, dodecane, hexane and cyclohexane) has been studied. The effect of type of working media (degree of hybridization of carbon atoms and molecule structure of hydrocarbons used) has been established.

Key words: amorphous carbon, structure, short-range order, graphite, diamond, synthesis methods, hydrocarbon liquids, electric breakdown.

N.V. GLEBOVA, A.A. NECHITAYLOV

PHYSICAL CHEMICAL TRANSFORMATION AT THERMAL ACTION ON NANOSTRUCTURED CARBON MATERIALS OBTAINED BY GRAPHITE MAGNETRON SPUTTERING

The transformations caused by thermal action on material obtained by direct current magnetron sputtering of graphite have been investigated. The reasons of the different behavior of a-C under the thermal action in air and in nitrogen atmosphere are discussed. Spectrophotometric method of analysis has been used to determine the transformation degree of material to graphite under annealing in a vacuum.

Key words: fuel elements, electro catalysis, amorphous carbon, graphite, composite, diamond, nano composite, film precipitation

G.A. DUBITSKY, N.R. SEREBRYANAYA, V.D. BLANK, E.A. SCRYLEVA, B.A. KULNITSKY, B.N. MAVRIN, V.V. AKSENENKOV, R.H. BAGRAMOV, V.N. DENISOV, I.A. PEREZHOGIN
ONION CARBON STRUCTURES: POWDERS AND COMPACTS

The article consists of two parts. The first part briefly reviews the production techniques and the applications of the onion carbon structures (OLS). The second part represents the results of investigations of the structure and properties of the OLS before and after high-pressure-high-temperature treatment. X-ray, electron microscopy, Raman spectroscopy and x-ray photoelectron spectroscopy (XPS) techniques were used. The hardness and the specific weight of products were measured.

Key words: onion carbon structures, nano diamonds, sp^2 - sp^3 - hybridization of carbon atoms, fullerite C_{60} , graphite, high pressure, high temperatures, crystal structure, hardness, specific weight.

A.N. BLAUT-BLACHEV, L.L. BUYLOV, V.I. ZOLOTAREVSKY, G.A. SOKOLINA, A.V. SHAPAGIN, B.V. SPITSYN

DIAMOND-CONTAINING FILMS WITH MICRO- AND NANO-CRYSTALLINE STRUCTURE SYNTHESIZED FROM ACTIVATED GAS PHASE

The diamond films with micro nano structure have been grown by the CVD method from gaseous mixture of CH_4/H_2 with application for activation of anomalous glow discharge of direct current. The films consist of grains with the sizes less than 50 nm. Electric resistance of the films was 10^6 – 10^8 Ohm.

Key words: diamond, nano crystalline diamond films, synthesis, CVD method, substrate.

I.A. BUBNENKOV, A.I. SOROKIN, A.S. KOTOSONOV, Yu.S. VERGILIEV, I.P. KALYAGINA, E.I. ZHMURIKOV, K.V. GUBIN, P.V. LOGACHEV

FEATURES OF GRAPHITIZATION OF CARBON BASED ON ^{13}C ISOTOPE

The graphitization of the carbon ^{13}C in a temperature range of 1200–2800°C has been studied. The isotope ^{13}C has been found to be a heterogeneously graphitizing carbon substance. On the base of data on diamagnetic susceptibility and high resolution electron microscopy it has been shown that a main isotope amount consists of crystallites of small sizes with disordered structure. For the first time, using the methods of measurements of specific resistivity and X-ray diffraction it has been experimentally established that in pre-crystallization period of ^{13}C isotope graphitization (1800–2100°C) the disorder of its structure occurs.

Key words: graphitization, isotope, ash content, constructive graphites, enthalpy, entropy, heterogeneous- graphitizing material, crystallite.

G.A. SOKOLINA, S.A. DENISOV, A.G. CHOPUROVA, S.V. BANTSEKOV, N.Yu. BOLDYREV, B.V. SPITSYN

ELECTRICAL CONDUCTIVITY OF MODIFIED NANO POWDERS OF DETONATING DIAMOND

The influence of chemical modification of detonating ultra dispersed diamond powders (UDD) on their electro conductivity G, measured in vacuum of $\sim 10^{-3}$ Torr in the temperature range of 293–730K has been studied. UDD modification has been carried by heating in hydrogen, at 850°C, in chlorine at 600°C and in carbon tetrachloride vapor at 450°C. The G(T) has been established to have the activation character for all UDD powders. Modification leads to change in the G value and conductivity activation energy E. G(T) change connects with the difference in functional composition of surface of UDD powders. It confirms with the change of Fourier IR-spectra and sample element composition. Modified UDD have higher hydrophobic properties of surface and keep quite high insulating properties.

Key words: detonating nano diamond, nano-diamond modifying, and electro conductivity of nano diamond powders.

A. V. DMITRIEV

MILLING OF CRYPTOCRYSTALLINE GRAPHITE AT WATER BOILING IN PORES

Powders of the plate form of particles were obtained using of earlier unknown property of cryptocrystalline graphite ore to destruct after humidifying and fast heating. The average size of flat flakes depending on parameters of destruction changes from 0.2 mm to 40 mm and more. The over crushed particles like dust are practically absent. The surface of particles is grey-black, matte, without traces of mechanical deformations and splitting. Averaged anisometry of plates is in limits from 13 to 22. In the work the process of destruction of cryptocrystalline graphite ore is discussed.

Key words: graphite, cryptocrystalline graphite, ore, anisometry, fraction, inter porous pressure

V.N. ANTSIFEROV, L.M. GREVNOV, M.F. TORSUNOV

STRUCTURE OF POWDER CARBON-CONTAINING COMPOSITIONS BASED ON IRON

Squeezing fullerene-containing compositions by the pressure of 9.5 GPa at the temperature 930°C leads to formation of local carbon phase which is disordered graphite. Synthesis of diamond takes place in local carbon phase under the pressure increase up to 13 GPa at the temperature of 930°C. A synthesis of fullerene-containing phase Fe_xC_{60} with period of lattice 12.3 angstrom (metal-fullerite 1) and fullerene-containing phase Fe_xC_{60} with period of lattice 14.4 angstrom (metal-fullerite 2) takes place at sintering compositions of iron-graphite at the temperatures of 650°C and 880°C. It was shown that during sintering the compositions iron-fullerene C_{60} and iron-nano-tubes at the temperatures of 650°C and 880°C the synthesis of fullerene-containing phase Fe_xC_{60} takes place.

Key words: fullerite, fullerene, cluster, nano tubes, composite, constructional materials, powder compositions, compacting.

V.Z. MORDKOVICH, A.R. KARAEVA, M.A. KHASKOV, I.S. ERMOLAEV

PROSPECTIVE WAYS FOR PRODUCTION AND APPLICATION OF LONG CARBON NANO TUBES

Long carbon nano tubes can become a cheaper alternative to carbon fibers based on conventional technology. The results of the present works have shown the possibility of production of centimeter-long carbon nano tubes by catalytic pyrolysis of carbon-containing compounds with application both catalysts on the fixed solid substrate and “flying catalysts”, i.e. in quasi-homogeneous process. The conditions for successful long carbon nano tube catalytic growth are formulated. The optimization of growth parameters showed that it is necessary to overcome three general limitations, which impede to achievement of their more length: slow growth; growth damping, competition between the nano tube elongation and the nano tube thickening.

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

G.P. OKATOVA, N.A. SVIDUNOVICH, D.V. KUIS, V.S. URBANOVICH, V.M. OYCHENKO, A.P. KORZHENEVSKY

STRUCTURE AND PROPERTIES OF NANOCOMPOSITE ON IRON BASIS AND NANO DISPERSED CARBON

It was shown, that at the conditions of intensive high temperature plastic deformation under high pressure in nano composite based on Fe-C the especially hard diamond-like carbon phase can be obtained not only from fullerenes, but also with use of cheaper nano carbon additives – fullerene containing soot, multi-wall nano tubes, and fullerene black.

Key words: nano composite, nano dispersed carbon, fullerenes, nano tubes, nano fibers, nano diamonds, phase transformations, arc fullerene-containing soot.

F.Kh. URAKAEV, V.S. SHEVCHENKO

PROSPECTS OF PROCESSING OF OFF-GRADE MATERIALS FOR HIGH TECHNOLOGIES BY METHOD OF NANO SIZE ABRASIVE-REACTIVE WEAR

Valuable information on the mechanisms of mechanical activation (MA) has been obtained by means of quantitative study of wear processes taking place in mechano-chemical reactors (MR). We concentrated our attention on two related aspects of MA in MR: (i) nano dimensional wear of the substances under treatment and the milling bodies; (ii) coat preparing on the surface of the milling bodies. A new technology called abrasive-reactive wear (ARW) has been developed. That technology utilizes the wear particles as a composite component of the reaction system rather than a harmful impurity. This technology is applied to the preparation of car-

bon-copper-silicon nano composites and coatings. It has been shown that during the process of mechanical activation of diamond-graphite-silicon system with application copper milling bodies the formation of powder copper-containing by-product as well as stable coats on the milling body surface occurs. The abnormal influence of graphite on the wear degree of copper garnitures of milling bodies has been quantitatively studied.

Key words: heterogeneous systems, mechanical activation, diamond, graphite, silicon, copper milling bodies, nano scale abrasive-reactive wear, nano composite materials, coatings, X-ray phase analysis, thermal conductivity.

N.Yu. BEYLINA

**RAW MATERIALS PROBLEMS OF STRUCTURAL GRAPHITES
FOR NUCLEAR-POWER COMPLEX**

Data on structure and properties of cokes and pitches as raw materials for graphitized goods applying in nuclear reactor constructions and components of nuclear power station equipment are generalized.

Key words: coke, pitch, crystallite, carbon structural materials, graphite, carbonization, graphitization.

Ch.N. BARNAKOV, A.P. KOZLOV, V.Yu. MALYSHEVA, S.K. SEIT-ABLAEVA, A.I. ROMANENKO, V.F. ANUFRIENKO, Z.R. ISMAGILOV

**METHOD OF BENZOPIRENE REMOVAL AT ANODE CARBON PRODUCTION INCLUDING
GRAPHITE PRODUCTION**

The catalytic method of benzopirene binding both at self-burning anode production and «green anode» forming at obtaining carbon anode material is considered. The carbonization of initial carbon occurs in the presence of 3d metals and temperature of 600-1000°C.

Key words: anode material, graphitization, carbonization, needle-shaped coke, coal pitch, benzopirene, perylene.

O.P. CHERNOGOROVA, E.I. DROZDOVA, I.N. OVCHINNIKOVA, E.E. ASHKINAZI
**FRictional PROPERTIES OF METAL COMPOSITE MATERIALS REINFORCED
BY PARTICLES OF SUPERELASTIC HARD CARBON**

The frictional properties of the metallic composite materials (CMs) reinforced by hard and elastic carbon particles obtained from fullerenes under pressure have been investigated under reciprocating motion over a high-carbon steel plate. The friction coefficient CMs for iron and cobalt matrixes is 0.08 and 0.04, respectively. They are lower than those of pure Fe and Co (C-free) (0.4 and 0.2, respectively) by a factor of 5.

Key words: wear resistance, frictional parameters, fullerene, graphene, composite materials, fullerite.