

JPRS-UCH-92-004
31 MARCH 1992



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CENTRAL EURASIA: Chemistry

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Formation of Highly Dispersed Aerosol in a Temperature Cycle

927M0072B Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 15 May 91) pp 635-639

[Article by A. M. Baklanov, A. N. Ankilov, Institute of Chemical Kinetics and Combustion, Siberian Division of USSR Academy of Sciences, Novosibirsk; UDC 536.421.4+532.614.3]

[Abstract] A phenomenological description of the formation of aerosols was presented. The authors proposed that one possible route of the generation and transformation of highly dispersed aerosols (HDA) in the atmosphere could

be a process in which air is cooled to a given temperature and then reheated to the original or even higher temperature. To test this hypothesis, an apparatus was constructed and experiments were carried out during summer and winter months in Novosibirsk. It was shown that cooling the atmospheric air purified of any aerosols to a given temperature followed by reheating the sample to the original temperature resulted in formation of HDA with concentrations of the order of 10^4cm^{-3} and particle size of about 10 nm; these aerosols exhibited high thermal stability. Several variants of experimental conditions were described. However, a more detailed analysis, evaluation of chemical composition of these aerosols or the mechanism of their formation were not possible due to a rather low output of their instrument. Figures 3; references 13: 3 Russian (1 by a Western author), 10 Western.

ALKALOIDS

Analysis of Physical Chemical Properties of Copper, Silver, Gold, and Halogen Compounds

927M0068F Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 (manuscript received 22 Oct 91) pp 1017-1021

[Article by Academician V. V. Kafarov, I. N. Dorokhov, V. N. Vetokhin, and L. P. Volkov, Chemical Technology Institute imeni D. I. Mendeleev, Moscow; Polytechnical Institute imeni V. V. Kuybyshev, Kuybyshev; UDC 541.24 088.8]

[Abstract] An analysis of the physical chemical properties of copper, silver, gold, and halogen compounds is used for the purpose of studying the effects of changes in the values of fundamental properties (totals of atomic order numbers comprising the molecules; molecular weights; chemical bond lengths and others) on changes in the values of derived properties (enthalpy of formation; Gibb's energy, heat capacity, entropy, phase transition temperatures, enthalpy of phase transition, etc.). Ordered sets of the above compounds in Mendeleev's periodic table manifest

stable systemic changes in the values of aggregated fundamental properties stemming from the multiplicity of interrelated changes in the values of aggregated derived properties. Analogous aggregates in the values of fundamental and derived properties of any single compound are strictly unique. Changes in property values are manifested quantitatively with upper and lower line limits. A systematic change in the values of aggregated fundamental properties corresponds to a systematic change in the values of aggregated derived physical chemical properties. Analysis of the changes in values of physical chemical properties of compounds in an interrelated set makes it possible to detect cause-effect, direct and reverse effects of compound properties during transition from one set of compounds to another, and from one compound to another within a given set. Qualitative and quantitative analysis of the changes in physical chemical properties makes it possible to readily determine the values of difficult-to-determine properties from those that are easily determined. Equations representing part of a computerized system of studies on halogen compounds of copper, silver, gold are presented. Reference 1 (Russian).

Catalytic Properties of Complexes of Palladium With Sorbents Containing Amino- and Iminodithiol Groups

927M0068E Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 (manuscript received 22 Oct 91) pp 1014-1016

[Article by A. K. Zharmagambetova, R. K. Ashkeyeva, Academician Ye. Ye. Yergozhin, and B. A. Utkelov, Organic Catalysis and Electrochemistry Institute, Alma-Ata; Kazan State University imeni S. M. Kirov; Chemical Sciences Institute, Alma-Ata; UDC 541.128+678-9]

[Abstract] Polymer-metal complexes represent a trend in fixed complex catalysis. The activity and selectivity of these systems in catalytic processes are functions of the composition and durability of the metal-polymer bond. By changing the functional groups of the ionites and the nature of their matrices, it is possible to alter their catalytic properties. In the present work an attempt was made to evaluate the possibility of affecting the catalytic activity of palladium by varying its donor environment in a polymer-metal complex. The palladium was fixed in the complexes with amino- and iminodithiol groups and styrene-divinylbenzene copolymer was used as carrier. Catalytic activity of the complexes was compared with conventional palladium carrier catalysts and homogeneous palladium-pyridine catalysts. Experiments demonstrate that the course of catalytic conversion of 2-propene-1-ol may be altered by varying the composition of the functional groups used to fix the palladium in the polymer. Thus, palladium complexes with nitrogen-containing polymers promote conversion of 2-propene-1-ol into propanol, while complexes containing the iminodithiol group promote

isomerization of the same compound into propanal. Figure 1; references 10: 7 Russian, 3 Western.

Pyridine Catalyzed Reactions of Alkanesulfoester Formation in Non-Aqueous Media

927M0068G Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 (manuscript received 24 Oct 91) pp 1028-1031

[Article by Yu. G. Skrypnik, V. P. Bezrodnny, and S. N. Lyashchuk, Physical Organic Chemistry and Coal Chemistry Institute, Donetsk, presented by Academician M. I. Kabachnik, 14 Oct 91; UDC 547.233+547.541+547.562]

[Abstract] A predominantly nucleophilic catalyst mechanism has been established in a study of the catalytic effect of pyridine bases in reactions of acid halides of carboxylic and arylsulfonic acids with nucleophilic reagents in non-aqueous media. Specifically, 4-dimethylaminopyridine, which has an abnormally high catalytic activity, has been referred to as a "super nucleophilic" catalyst, although there are cases where the question of pyridine catalysis remains open. Until now, research on alkanesulfonation processes has been directed to studies of the catalytic effects of trialkylamines where it has been demonstrated that the process flows according to two competing mechanisms: elimination of addition, sulfene (activation of the substrate), and basic catalysis (activation of the reagent). A study of catalysis with pyridine (less basic but more nucleophilic than trialkylamines) presupposes resolution the above two mechanisms. In the present work chemical kinetics, quantum chemistry, and molecular mechanics were employed to demonstrate that the alkanesulfonation process proceeds along competing streams of both a sulfene mechanism and a basic catalysis mechanism. References 13: 10 Russian, 3 Western.

CHEMICAL INDUSTRY

Macrokinetic Rules of Chemical Sorption Process in Gas-Liquid Reactors

927M0072H Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 6 May 91) pp 683-687

[Article by A. Ya. Fedorov, L. P. Kholpanov, correspondent member of USSR Academy of Sciences V. A. Malyusov, All Union Scientific Research and Design Institute of Monomers, Tula; UDC 66.06663.8.001.57.519.6]

[Abstract] In the present work, an analysis of the processes taking place in bubbling reactors was reported. A two level

model of the reactor was considered which made it possible to analyze these processes on the level of elemental chemical sorption process as well as on the level of the totality of processes taking place in the reactor. Specifically, analysis of a second order reaction with a transient reagent A was carried out using the Kishinevskyy model to describe the elemental process of chemical sorption. Equations were developed for three possible operational conditions: the border layer regimen for rapid chemical reactions occurring in diffusion-reactive border layers, the continuous phase regimen for slow reactions within the core of the liquid stream and an intermediate regimen covering both possibilities. Figure 1; references 14: 11 Russian, 3 Western.

Evaluating Characteristics of Accidental Explosion of Surface Level Air-Vapor Cloud

927M0068A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 (manuscript received 19 Jun 91) pp 978-983

[Article by B. Ye. Gelfand, G. M. Makhvidadze, V. B. Novozhilov, I. S. Taubkin, and S. A. Tsyganov, Problems of Mechanics Institute, Moscow; Chemical Physics Institute, Moscow, presented by Academician A. D. Kuntsev, 30 Apr 91; UDC 532.539.2:656.08]

[Abstract] One of the most widespread and dangerous types of industrial accidents is the explosion of an air-vapor cloud formed as a result of damaged industrial equipment, product pipelines, or during vaporization of flammable liquid spills. Despite significant

industrial safety efforts, these accidents occur rather frequently and result in great property damage. One of the major and inevitable problems in accident analysis lies in establishing the total quantity of combustible material involved in the energy release. While direct determination of this quantity is often difficult, the establishment of a relationship between the total mass of reacted combustible material and the observed consequences of an accident would make it possible to predict probable loss and carry out argumentative expertise in resolving the circumstances of an industrial catastrophe. In the present work a quantitative analysis was made of the hydrodynamic effects caused by the evolution of a floating fire ball, as evidenced in the Bashkir (1989) and Port Hudson disasters. Figures 4; references 8: 7 Russian, 1 Western.

ELECTROCHEMISTRY

Radiation Copolymerization of N-Vinylpyrrolidone With Unsaturated Carboxylic Acid Salts

927M0072C Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 20 May 91) pp 653-655

[Article by D. P. Kiryukhin, V. N. Ushakova, V. M. Munikhes, Ye. F. Panarin, academician V. I. Goldanskiy, Division of Institute of Chemical Physics imeni N. N. Semenov, USSR Academy of Sciences, Moscow; Institute of High Molecular Compounds, USSR Academy of Sciences, Leningrad; UDC 542]

[Abstract] Copolymers of N-vinylpyrrolidone (VP) and unsaturated carboxylic acids are widely used in medicine. The preparation method normally used for this copolymerization process leads often to undesirable side reactions lowering the final yield. It is possible to avoid some of

these losses by replacing free acids with their alkali metal salts. In the present work the kinetics of radiation copolymerization of VP with the sodium salt of crotonic acid (CANa) was investigated varying the reagents ratio and their concentrations, employing γ -radiation doses of 0.25-2.0 G/s. The reaction temperature was 298 K. It was shown to be possible to achieve a 100% yield of the copolymer which contained 13.6 to 15 mole-% of crotonic acid. Effects of the increasing irradiation dose, dilution of the starting solution, concentration of the monomers in the starting solution were investigated. It was shown that using CANa instead of the free acid made it possible to avoid the hydrolysis and alcoholysis of VP so that an effective copolymerization could take place. The copolymers obtained by this method could be used as carriers for biologically active materials. Figures 2; references 9: 8 Russian, 1 Western.

Pulsed Ultrafiltration

927M0060A Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 23 May 91) pp 867-880*

[Article by S. S. Dukhin, V. P. Dubyaga, A. V. Listovnichiy, and A. A. Povorov, Colloidal Chemistry and Hydrochemistry Institute, Kiev; UDC 66.06.7.38]

[Abstract] One of the factors inhibiting baromembrane technology is concentration polarization, which consists of an increase in the concentration of particles retained on the membrane surface. An important stage in the efforts to minimize its effects was the implementation of tangential flow along the surface of the membrane, wherein the retaining membrane particles are continuously entrained in a liquid stream to minimize particle accumulation near the membrane surface in the concentration polarization zone. Under laminar and turbulent flow conditions, brownian and turbulent diffusion also takes place. Periodic interruption of the filtration stream, as opposed to reverse filtration, has the advantages of a relatively simple technology and no problems related to re-combining of the filtrate with the concentrate. This method could also be effective in ultrafiltration owing to the high mobility of inorganic and organic ions which facilitates their rapid transport from the filter cake into the tangential liquid stream during the pause interval. Mathematical descriptions of filter cake accumulation and its packing during the pause interval are presented and discussed. Figures 6; references 15: 12 Russian, 3 Western.

Electro-Membrane Determination of ζ -Potential of Colloidal Particles

927M0060B Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 22 Apr 91) pp 881-882*

[Article by A. P. Krivoruchko, O. R. Shendrik, M. I. Ponomarev, and P. I. Kupriyenko, Colloidal Chemistry and Hydrochemistry Institute, Kiev; UDC 621.359.7]

[Abstract] Presently, the ζ -potential of particles is determined chiefly by microelectrophoresis and the mobile boundary methods. The former involves the use of complex equipment and yields divergent results during analysis of polydispersed systems. The latter method requires clear liquid-sol contrast and constant temperature conditions to prevent convection currents. In the present work a method is proposed for determining ζ -potential of colloidal particles in membrane systems using a porous permeable diaphragm. Applying an external electrical field to such a system results in transfer of the colloidal particles through the porous diaphragm from one chamber to another. By measuring the concentration of particles over a period of time in the first chamber, it is possible to determine ζ -potential. By using this method on a 25 percent aerosil solution, a value of 28.6 \pm 2.9 mV was obtained. This is close to the 24.4 mV figure obtained with microelectrophoresis. This error may be further reduced by improving the design of the electrochemical cell and using better measuring conditions, i.e. current density and time interval. Figure 1; references 4 (Russian).

Equilibrium Adsorption of Surfactants by Activated Charcoals Having Various Porous Structures

927M0060C Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 27 Jun 91) pp 883-887*

[Article by S. K. Smolin, N. A. Klimenko, and M. N. Timoshenko, Colloidal Chemistry and Hydrochemistry Institute, Kiev; UDC 628.16.081.32]

[Abstract] Carbon sorbents are recommended for treating waste effluent heavily contaminated with organic substances. However, as the size of the organic molecule increases, the probability for a significant portion of the sorbent to be inactive also increases. In these cases the finest micropores having the greatest energy of sorption, become a useless part of the structure. For this reason, it is often recommended to use sorbents with a well developed system of mesopores. It is also known that the energy of selective adsorption of organic substances in transitional pores is actually equal to the sorption energy of non-porous surfaces. Therefore, increasing the mesopores of a sorbent by decreasing the volume of micropores on the one hand makes the internal structure of sorbent more accessible to the sorbate, but on the other hand it lowers the capability of the carbon for selective leaching of organic contaminants in heavily contaminated water. In the present work a study was made of the adsorption of OP-10 and sulfonol on AG-3, KAD, and SKND-1 activated charcoals to determine effective conditions for treating waste effluent heavily contaminated with surfactants. Selective adsorption of the adsorbents is shown to be a function of the volume of true micropores. Mesopores become an important factor under conditions of adsorbate association. The shape of the adsorption isotherm at equilibrium concentrations greater than KKM_1 is mostly due to competition between adsorption and micellar systems. Figures 3; references 11 (Russian).

Mass Transfer in a Flat Channel of Ultrafiltration Membrane Equipment

927M0060D Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 29 Apr 91) pp 894-899*

[Article by V. D. Volgin, Ye. D. Maksimov, and T. V. Sedyakina, "Mir" SPA, Mosocw; UDC 66.0671.62-278:532.5]]

[Abstract] Ultrafiltration equipment is designed in such a manner that the liquid being separated flows between two membranes in a planer channel. Although encountered previously, the processes taking place in this equipment have not yet been rigorously described. Most frequently, laminar flow was examined using analytical and numerical methods, and standard methods of the theory of similarity were used for turbulent flow. In the present work a mathematical description is presented on the process of mass transfer in a planer membrane channel under both laminar and turbulent flow for the case where the solution could form a gel on the membrane. Expressions were derived which include both the properties of the liquids

and characteristics of the channel. The laminar-turbulent flow transition boundaries and mass transfer through several membranes was studied experimentally. Satisfactory agreement was obtained between experimental and computed results for permeation of liquids containing colloidal particles. Permeation is little affected by the height and length of the membrane channel for these liquids under turbulent flow conditions. Figures 5; references 8: 6 Russian, 2 Western.

Composition of Triton X-100 on Surface of Synthetic Carbon-Containing Sorbent

927M0060E Kiev KHIMIYA I TEKHOLOGIYA
VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 26 Mar 91) pp 900-960

[Article by T. V. Karmazina, N. A. Klimenko, B. P. Nikolayev, A. M. Shlyakov, D. K. Toropov, M. A. Glikin, and N. P. Alekseyeva, Colloidal Chemistry and Hydrochemistry Institute, Kiev; Very Pure Biopreparations Institute, Leningrad; Methanol Project SRI (State), Severodonetsk; UDC 541.183]

[Abstract] Carbonization is a method of increasing the sorption capacity of silica gels in respect to organic compounds such as non-ionic surfactants. The sorption capacity of such synthetic carbon-containing sorbents increases markedly during sorption from aqueous solutions with surfactant concentrations exceeding the critical micelle-forming concentration. In resolving practical problems associated with leaching organic compounds from aqueous solutions, it is essential to have an understanding of the composition of the layers formed on the sorbent. In the present work the layer formed during adsorption of non-ionic surfactant triton X-100 on a synthetic carbonized sorbent, prepared by carbonization of silica gel, was studied. The surface of the synthetic carbonized sorbent is heterogeneous in magnitude of hydrophobic interaction. This causes oriented interaction with nearby layers and randomization of remote layers. Figures 3; references 6 (Russian).

Determination of Nitrates in Waters Using Ion Chromatographic and Ionometric Methods

927M0060F Kiev KHIMIYA I TEKHOLOGIYA
VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 20 May 91) pp 904-908

[Article by A. T. Pilipenko, Yu. V. Bolshak, O. V. Zuy, and T. M. Manilevich, Colloidal Chemistry and Hydrochemistry Institute, Kiev; UDC 543.3]

[Abstract] Nitrate contamination of water, soil, plants, and food products requires analytical control over nitrate ion content. The various techniques currently in use are not entirely satisfactory owing to the need for special apparatus, harmful reagents, or large amounts of time. Ion chromatography and ionometry appear promising and have many advantages. In the present work ion chromatography was used to determine nitrate, bicarbonate, chlorine, sulfate, nitrite, and phosphate ions with the aid of sorbent KhIKS-1 and carbonate-bicarbonate eluent. Ionometry was used to determine nitrate ions with the aid of

nitrate-selective electrode EM-NO₃-01. A barium sulfate reference electrode is recommended for field use to improve accuracy. Both methods may be used under laboratory and field conditions. Figures 3; references 20: 13 Russian, 7 Western.

Quantitative Group Composition of Oil Products Dissolved in Water

927M0060G Kiev KHIMIYA I TEKHOLOGIYA
VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 29 Apr 91) pp 909-911

[Article by A. V. Dolgoplova, D. F. Kushnarev, Kim En khva, G. A. Kalabin, and F. K. Shmidt, Oil and Coal Chemistry Synthesis Institute at Irkutsk State University; UDC 543.38]

[Abstract] Oil and oil products are major contaminants in natural and waste water. Their toxicity is related to the soluble and stable oil components. The complexity of the hydrocarbon and heteroatomic composition of oil and its products and the presence of water-soluble additives are such that the solubility values of standard hydrocarbons and heteroatomic molecules are invalid for evaluating the "potential" solubility of oil products. Also, individual components react with water to form water-soluble derivatives. Transfer of oil products from a film into solution may be intensified as a result of the increase in contact surface of the heterogeneous media formed by insoluble components of the oil products. In the present work ultraviolet and nuclear magnetic resonance spectra were used to study the composition and distribution of oil products in water. Concentrations of water soluble-fractions of various oil products were determined and the selectivity of oil product solubility was established. The resulting data may be used to evaluate the environmental effects of soluble oil products and recommend suitable methods for treating oil-contaminated effluents. Figure 1; references 4: 3 Russian, 1 Western.

Effect of Traces of Surfactants on Properties of Anionite Membranes

927M0060H Kiev KHIMIYA I TEKHOLOGIYA
VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 25 Feb 91) pp 915-918

[Article by L. K. Berkeliyeva, R. D. Chebotaryeva, O. V. Grebenok, and Kh. N. Yevzhanov, Colloidal and Hydrochemistry Institute, Kiev; UDC 541.183.12]

[Abstract] Membrane poisoning with surfactants is one the main obstacles to widespread use of electro dialysis in water recycling systems. When an electric field is applied, the surfactant ions are deposited onto the oppositely charged membrane surface thereby causing a drop in limiting current. At low surfactant concentrations, this effect may not be observed until after hundreds of hours of membrane operation. In the present work a study was made of the effects of trace amounts of sulfonol on the properties of MA-40, MA-100, and MA-41I membranes during electro dialysis of aqueous solutions of sodium chloride and sodium nitrate. It was demonstrated that after prolonged operation of the membrane equipment, the

electrical resistance increases, the ion exchange capacity of the membranes decreases, and they assume asymmetric volt-ampere curves. Therefore, the presence of sulfonol in mineral salt solutions leads to a gradual increase in membrane voltage caused by adsorption and surfactant film formation on the membrane surface which leads to an irreversible drop in ion exchange capacity and a rise in electrical resistance of the membrane. After 800 hours of operation at 1 ampere per dm^2 , the transport characteristics of anionite membranes changed insignificantly. Figures 2; references 10: 9 Russian, 1 Western.

Activated Anthracite - Effective Sorbent for Treating River Water

927M0060I Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 8 Jan 91) pp 918-922*

[Article by M. N. Timoshenko, V. S. Besan (deceased), P. V. Golyuk, and V. R. Myravyev, Colloidal Chemistry and Hydrochemistry Institute, Kiev; UDC 628.16.067.1]

[Abstract] The problem of removing soluble contaminants from water may be resolved by adsorption on activated charcoals. However, the high cost and scarcity of activated charcoals requires a broadening in the variety and output of effective sorbents. Tests were conducted at the Dnieper Water Station in Kiev on activated anthracite in comparison to industrial activated charcoals AG-3 (GOST 20464-75), KAD-iodine (TU 6-16-1917-74), and Chemvion F-300 (MERCK and Rahway N.I.). The results demonstrated that activated anthracite, produced jointly by the Colloidal Chemistry and Hydrochemistry Institute and the Gas Institute, Kiev, is a satisfactory filtering material and may be used as an upper filtration layer in double layer rapid filtration units. The tested samples also adsorbed radio-nuclides Cs, Ru, Ra, Th, and Sb. Figures 2; references 2 (Russian).

Optimization of Technological Parameters in Industrial Effluent Treatment by Coagulation

927M0060J Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 14 Apr 91) pp 928-930*

[Article by N. N. Svechina, T. N. Belyayeva, and T. F. Kalugina, Civil Engineering Institute, Ivanov; UDC 628.162.5]

[Abstract] The reagent method is used to treat industrial effluents containing heavy metals in the preliminary stage in direct-flow water treatment units. The method consists of using either coagulants or alkali metals to form flocculent precipitates of hydroxides of the heavy metals which then act as adsorbents for organic compounds. Design layouts for this type of treatment usually include neutralizers, mixers, settling tanks, and other equipment for treating the extracted precipitate. Although various methods are used in the selection of design and equipment, all methods are based on volume of treated water and residence time of the effluent in the the equipment. Thus, as the residence time in the settling tank is reduced, the economic index of water clarity improves. In the present

work some relationships for extraction of heavy metal ions from effluents using alkalizing reagents are presented. Optimization of technological parameters in reagent treatment of industrial effluents is based on computing the hydrogen environment index and the consumption of chemicals under conditions of minimal metal ion concentrations. The computation method consists of determining the equilibrium concentrations of all of hydrated metal ions at various pH values, water temperatures, and contaminant content. References 4 (Russian).

Extracting Zinc by Sorption from Rinse Water of Chemical Fiber Production

927M0060K Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 17 May 91) pp 930-933*

[Article by A. G. Kholmogorov, L. V. Burakova, and G. P. Vdovina, Chemistry and Chemical-Metallurgical Processes Institute, Krasnodarsk; UDC 669.536]

[Abstract] The rinse water resulting from chemical fiber production using sodium sulfate-sulfuric acid solutions must be regenerated with reagents, since they cannot be directly recycled owing to the high concentrations of zinc and sodium sulfates. Recycling is possible only after the sodium and zinc ions are removed by ion exchange. In the present work a study was made of the sorption extraction of zinc from chemical fiber effluents containing 30-75 mg Zn per dm^3 using cationite exchange resins KB-2 and KB-2E. Optimum sorption took place at pH 5-3.5 on KB-2E cationite. This cationite is recommended for process testing in two-stage zinc concentrating units from rinse effluents containing over 100 grams zinc per dm^3 . Figures 5; references 5 (Russian).

Preservation of Water with Silver in Containers of Various Materials

927M0060L Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 22 Apr 91) pp 948-952*

[Article by O. S. Savlyuk, Ye. Yu. Deynega, A. V. Terletskaia, and V. N. Kosinova, Colloidal Chemistry and Hydrochemistry Institute, Kiev; UDC 576.8.22:828.162.8]

[Abstract] The problem of prolonged storage of potable water takes on added significance as a result of the continuing contamination of natural reservoirs. Many foreign countries refrain from using water from open sources and obtain potable water from artesian wells, desalinating units, and even glaciers. A threat of further contamination arises with the use of certain materials for containers while transporting water. Some substances promote growth of various microorganisms. Results of biological testing of drinking water stored aboard ships of the Black Sea fleet indicated that the micro-flora not only flourished in the water, but also multiplied. In the present work a study was made of the storage of water treated with silver ions in containers made of various materials. A relationship was established for the change in silver ion concentration as a function of the surface structure of the container material

and its electrochemical potential. A method for milling the surface of stainless steel making it suitable for prolonged water storage is recommended. Figures 3; references 7: 4 Russian, 3 Western.

Bacteria Which Clean Industrial Effluents from Cationite Surfactant Production

927M0060M Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 10, Oct 91 (manuscript received 15 Apr 91) pp 952-955*

[Article by L. A. Taranova, O. S. Radchenko, and S. V. Grishchenko, Colloidal Chemistry and Hydrochemistry Institute, Kiev; UDC 579.695]

[Abstract] The most toxic contaminants of cationite surfactant production effluent are nitriles and amines. Research on the biological breakdown of nitriles is being conducted along several directions. Some work is devoted

to improving the capability of microorganisms to breakdown nitriles, while in other work microbial destruction is studied as a possible means of enriching shale oil. An interesting trend is the use microbial destruction of nitriles to treat waste effluents. While bio- destruction of primary alkylamines has been established, data are lacking on treating cationite surfactant production effluent. In the present work a study was made of the microbial cenosis occurring in the above effluent during treatment. Highly active strains of nitrile- and alkyldimethylamine-destroying bacteria were obtained. The most active strains were *Rseudomonas sp. T* and *Rseudomonas stutzeri T*. It was demonstrated that a high concentration of such specific contaminants as nitriles and alkyldimethylamines in a treating system populated with breakdown bacteria also serves as strong selective factor, almost precluding the appearance of other microorganisms. References 17: 6 Russian, 11 Western.

INORGANIC COMPOUNDS

Metallized Cyclic Cation From Adduct of Solvomercurized Ortho-Nitrophenylcyclopropane; Study of its Structure by NMR H and C¹³ Methods

927M0068B Moscow *DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 (manuscript received 15 Oct 91) pp 988-992*

[Article by S. S. Mochalov, S. G. Bandayev, Yu. S. Sharbarov, and Academician N. S. Zefirov, Moscow State University imeni M. V. Lomonosov; Dushanbe State Pedagogical Institute imeni K. Sh. Dzhurayev; UDC 547.545+547.786+547.254.9]

[Abstract] In previous work devoted to the behavior of 3-chloromercuro-substituted 1-(2-nitrophenyl)propanol-1

and its formates under acid-catalyzed conditions, it was demonstrated that corresponding mercury-substituted ortho-nitrobenzenes, in the presence of concentrated sulfuric acid, are capable of being converted into β -mercurized 2-nitrosopropiophenols. It was postulated that the intermediates, responsible for the end results, are sulfates of the corresponding benzisoxasoline ions, which are capable of rearrangement into ortho- nitrosoacylbenzenes. In the present work, NMR spectra and C¹³ confirmed that mercury-containing cyclic benzisoxasolinium ions are indeed formed during conversion of 2- (2-nitrophenyl)-1-formylhydroxy-3-chloromercuropropane in accordance with the above scheme, the intermediates being somewhat less stable than the non-metallic analogs. Figure 1; references 5: 4 Russian, 1 Western.

The Impurity Content of Samples From the Permanent Exhibition of High-Purity Substances. IV. Volatile Inorganic Hybrids

927M0056A Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 4, Jul-Aug 91 (manuscript received 7 Feb 91) pp 7-13

[Article by G.G. Devyatykh, V.A. Krylov, I.D. Kovalev, L.I. Osipova, S.V. Yankov, Ye.N. Volkova, Chemistry of High-Purity Substances Institute, Nizhniy Novgorod; UDC 54-482;543.064]

[Abstract] This article is one in a series of publications devoted to the impurity content of highly pure substances contained in the Permanent Exhibition of High-Purity Substances. Documentation data are presented on 15 samples of seven substances classified in the exhibition as volatile inorganic hybrids. The seven hybrids profiled are as follows: silane, germanium, ammonia, arsine, hydrogen sulfide, hydrogen selenide, and hydrogen telluride. Seven tables are presented. Each details the molecular percentage of each of the impurities present in a different one of the seven samples. The data presented were obtained by gas chromatography, mass spectrometry, submillimeter and infrared spectroscopy, and atomic emission spectroscopy. In addition to the aforementioned tables, this article also includes information regarding the procedures used to analyze the samples and some broad generalizations regarding the levels of selected impurities (such as fixed gases and hydrocarbons) in the specimens. Figures 4, tables 7; references 7 (Russian).

Analytic Control of Semiconductor Silicon

927M0056B Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 4, Jul-Aug 91 (manuscript received 22 Mar 91) pp 31-37

[Article by Yu.A. Karpov, M.N. Shchulepnikov, D.V. Mormilitsyn, and V.I. Firsov, State Scientific Research and Design Institute of the Rare Metal Industry; UDC 669.782:621.315.592:543.530+543.420.62]

[Abstract] The importance of semiconductor silicon in such diverse fields as computers, fiber-optics, and solar power has created a critical need for the development of a standard analysis technique to control its purity. The analysis method selected must meet a number of requirements. It must be capable of detecting a fairly large number of elements—at least 10 to 15 and, in some cases, 30 to 40 or more. In addition, the analysis method must be capable of detecting such diverse types of elements as the electrically active elements of groups III and V of the Periodic Table, impurities creating deep energy levels (including cobalt, nickel, and manganese), and elements with high electron capture cross sections that are highly prone to recombination (gold, silver, iron, and platinum). The method must also be able to detect the presence of these elements in very small amounts. Chemical-spectral techniques have recently been developed that make it possible to determine 25 to 30 impurity elements with detection thresholds of 10^{-5} to $10^{-8}\%$. Chemical-spectral analysis has the additional advantage of reliance upon readily accessible equipment that is relatively easy to

calibrate; however, chemical-spectral techniques entail a risk of contamination of the test sample during the concentration stage. Solid-state mass spectrometry (including secondary-ion mass spectrometry and laser mass spectrometry) likewise appears both promising and problematic from the standpoint of analyzing semiconductor silicon. The period between 1984 and 1990 was one of extensive research in the area of using neutron-activation analysis to study silicon. In 1986-1987, four different laboratories (in the USSR, Germany, and Hungary) examined test samples of silicon. The results obtained by the different laboratories with respect to nickel, copper, sodium, and arsenic were in fairly good agreement with one another. More significant discrepancies were found in the data regarding antimony and molybdenum. The Chemistry of Highly Pure Substances Institute of the USSR Academy of Sciences and the State Scientific Research and Design Institute of the Rare Metal Industry have recently collaborated to create a standard specimen of high-purity silicon containing the following certified elements (% by mass): Na, 5.9×10^{-8} ; Cr, 2.4×10^{-9} ; Ni, 3.2×10^{-7} ; Cu, 3.3×10^{-8} ; As, 7.3×10^{-9} ; Mo, 1.3×10^{-8} ; and Sb, 1.6×10^{-10} . The upper limits of the content of an additional 60 uncertified elements were set between 2×10^{-12} and $4 \times 10^{-5}\%$ (by mass). A procedure was also established whereby oxygen and carbon in silicon are detected by activation of samples by accelerated He^{3+} ions (with a detection threshold of $n \times 10^{-7}\%$ under optimal conditions). A number of problems still remain in the area of analytic control of semiconductor silicon. Included among them are 1) the problem of further reducing detection thresholds, 2) the problem of eliminating possible sources of contamination of test samples, and 3) the need to standardize the many methods currently being developed at different institutions. Tables 2; references 4 (Russian).

The Structure and Properties of Platinum Alloys Produced by Melting in a Cold Crucible

927M0056C Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 4, Jul-Aug 91 (manuscript received 10 Dec 90) pp 57-60

[Article by N.M. Slotintsev, V.I. Bogdanov, and Ye.I. Rytvin; UDC 69.018.45]

[Abstract] Many base metal impurities have a deleterious effect on the service performance of platinum alloys. Most of the said impurities enter the alloy from the starting batch, so refined platinum metals contain a significant portion of impurities in the form of microinclusions. In view of these facts, the authors of the study reported herein worked to develop a new process to obtain high-quality platinum alloys. Specifically, they studied the effect that the parameters of the process of melting in a cold crucible have on the structure and content of microinclusions in platinum alloys. An Epikvant-type automatic analyzer was used to perform a quantitative metallographic analysis of the said microinclusions; their dimensions were measured with an error of 0.5 μm . A qualitative analysis of the microinclusions was performed on a Kamebaks MBKh-1 T-25 X-ray spectrum microanalyzer with an accelerating voltage of $U = 10 \text{ kV}$ and with an absorbed current

between 10 and 15 nA along with a spectrograph with energy dispersion. Specimens of the alloy PtRh 35-0.1 smelted from platinum and rhodium powders were used to study the effect of the medium. Specimens of the alloy PtRhIZIKh 20-0.02-0.02-0.02-0.02 were used to study the effects of such parameters as crystallizer diameter and induction coil migration velocity on the number of microinclusions per unit area of specimen, the maximum microinclusion diameter, and relative microinclusion volume. Analysis of the characteristics of microinclusions in alloys smelted in a crucible with a crystallizer diameter of 40 or 50 mm showed that specimens obtained with induction coil migration velocities of 3 and 20 mm/min had the fewest microinclusions. In the case of a crystallizer diameter of 60 mm and a migration velocity of 30 mm/min, there were fewer than 10 microinclusions per specimen. Using a migration velocity of 3 mm/min resulted in fewer and smaller microinclusions than did migration velocities of 10 or 20 mm/min. A rather distinct correlation between heat resistance and microinclusion characteristics was also observed: the greatest volume fraction of microinclusions corresponded to the minimum heat resistance. The results obtained confirm that by varying the process parameters of melting in a cold crucible, it may be possible to significantly alter the structural characteristics and content of nonmetallic inclusions in platinum alloys and thereby increase their refractory properties. Figure 1, tables 2; references 4: 2 Russian, 2 Western.

The Effect of Germanium and Gadolinium Doping on the Thermal Stability of Dislocation-Free Monocrystalline Silicon

927M0056D Moscow VYSOKOCHISTYYE
VESHCHESTVA in Russian No 4, Jul-Aug 91
(manuscript received 8 Jan 91) pp 61-64

[Article by V.V. Borshchenskiy, D.I. Brinkevich, N.I. Gorbacheva, V.V. Petrov, and V.S. Prosolovich, Belarus State University imeni V.I. Lenin, Minsk; UDC 546.28:621.315.592]

[Abstract] The authors of the study reported herein examined n-Si dislocation-free monocrystals grown by the Czochralski method from a melt containing germanium and gadolinium dopants. (Germanium was used as a representative isovalent dopant, and gadolinium was used as a representative rare earth element. The monocrystals, which had a resistivity of about 10 Ω -cm, were subjected to heat treatment in air at 450 and 650°C for up to 100 hours. Tests performed on the crystals indicated that germanium and gadolinium are both effective getters for process oxygen and carbon in the study silicon melt, with the getter effect being more pronounced in the Si:Gd mixtures. On the basis of their own experiments and previously published data, the authors concluded that the getting mechanisms of Si:Ge and Si:Gd should differ from one another. Specifically, they concluded that in the case of Si:Ge, the dominant factor is the decrease in the segregation coefficients of C and O (this is because germanium did not appear to have any noticeable effect on the dissolution of the crucible and no slag formation and precipitation was

noted). Adding Gd, which increases the solubility of a quartz crucible, results in an increase in N_0 . On the other hand, by binding oxygen and carbon in the melt, lanthanides prevent them from entering the growing crystal, which results in a getter effect in Si:Gd. Its intensification and reduction of the concentration of germanium in Si:(Ge, Gd) is confirmation of the interaction of Gd and Ge dopants in the melt. The authors also discovered that stabilizing annealing for a period of 30 minutes accelerates the process of the generation of high-temperature heat donors. This effect was most pronounced in Si:Gd (where the maximum attainable concentration increased by about 45%) and in the control material (about a 35% increase). Stabilizing annealing had virtually no effect in the Ge-doped specimens, however. Specimens doped with both Ge and Gd had a much higher heat stability than did the control material or specimens doped with either Ge or Gd alone: Adding Gd alone did slow the accumulation of high-temperature heat donors, albeit not to the extent that the simultaneous addition of Ge and Gd did. Ge added in a concentration of about $1 \times 10^{20}/\text{cm}^3$, on the other hand, did not have any noticeable effect on processes of high-temperature heat donor generation. Tables 2; references 9: 5 Russian, 4 Western.

Positron Spectroscopy of Radiation Defects in Vanadium

927M0056E Moscow VYSOKOCHISTYYE
VESHCHESTVA in Russian No 4, Jul-Aug 91
(manuscript received 18 Jan 91) pp 83-87

[Article by S.N. Mayev and N.F. Miron, Physicoenergy Institute, Obninsk; UDC 621.039.531:546.881]

[Abstract] The authors of the study reported herein examined the effect of interstitial impurities (O, N, and C) on the process of annealing defects at temperatures from 20 to 560°C in plastically deformed, neutron- and electron-irradiated vanadium. Vanadium disks 10 mm in diameter and 1 mm thick were cut by the electrospark technique from a monocrystalline bar whose lengthwise axis coincided with the direction (100). The disks were subjected to mechanical grinding and chemical polishing. They were then annealed at a temperature of 1,400°C under a pressure of 2×10^{-5} mm Hg for 2 hours and then slow-cooled. The starting specimens (after chemical polishing) were subjected to neutron irradiation in a VVR-Ts reactor at a temperature of about 100°C to a fluence of 4.5×10^{24} neutrons/m² ($E \geq 0.1$ MeV). The annealed specimens were subjected to electron irradiation ($E = 3.5$ MeV) at room temperature to a fluence of 4×10^{22} electrons/m². The annealed specimens were deformed by effecting a relative change in their thickness on the order of about 25%. After the irradiation and annealing, the specimens were again subjected to chemical polishing. The spectra of the angular distribution of the annihilation photons were measured at room temperature with a resolution of about 1 mrad. Test specimens were then placed in a thermal chamber together with a positron source (the radionuclide ²²Na) and annealed to 560°C at a pressure of 10^{-3} mm Hg. Processing and analysis of the spectra of the angular distribution of the annihilation photons revealed that the half-width ($\theta_{1/2}$)

(i.e., the width of the spectrum at half its height) of an annealed specimen was very different (i.e., much smaller) than that of a starting specimen. This was hypothesized to be related to interaction between the interstitial impurities and defects. The spectrum of the lifetime of the positrons before annihilation was found to contain two components. The first, $\tau_1 = 120 \pm 5$ ps reflects the positron's lifetime in the lattice. The component τ_2 , which amounted to 250 ± 8 ps at 20% intensity, was interpreted as a sign that micropores (vacancy clusters with a radius of 3-4 angstroms) are present in the lattice. Neutron irradiation did not appear to change the situation significantly, even though a whole spectrum of radiation defects were generated. Electron irradiation and plastic deformation of annealed specimens resulted in a narrowing of the spectrum of the angular distribution of the annihilation photons, which was not unexpected. The studies confirmed that interstitial impurities will have different effects on a metal depending on the metal's starting conditions, the types of treatment to which it is subjected, and the conditions under which the treatment is rendered. The presence of thermal stable micropores has been detected in starting vanadium monocrystals. This thermal stability is a consequence of interaction between impurities and defects and is not significantly altered by neutron irradiation of the starting vanadium. In the temperature interval from 20 to 200°C, electron irradiation of vanadium causes the decomposition of its impurity atom-inherent interstitial atom complexes and the migration of the interstitial atoms. At temperatures above 200°C the vacancies start to move, and the pore formation process begins. Only the vacancy migration stage is observed in deformed vanadium. The elevated temperature of stage 3 is determined to be a result of the interaction of the vacancies and impurity atoms. Figures 2, table 1; references 11: 4 Russian, 7 Western.

Investigation of the Coprecipitation of Cu (II) on Magnesium Hydroxide

927M0056F Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 4, Jul-Aug 91 (manuscript received 20 Mar 91) pp 144-149

[Article by L.K. Kurmanguzhina, I.N. Marov, G.A. Yevtikova, A.A. Fakeyev, and B.V. Zhadanov, All-Union Scientific Research Institute of Chemical Reagents and Ultra-Pure Chemicals, Moscow; UDC 546.56.46:541.183,2:543.422.B:541,67]

[Abstract] The authors of the study reported herein examined the coprecipitation of Cu (II) on magnesium hydroxide in the pH interval from 10 to 14. EPR spectra of Mg:Cu in a 1:0.001 ratio were taken at room temperature, 77 K, and 300 K. Analysis of the EPR spectra recorded enabled the authors to draw a number of unequivocal conclusions regarding the nature of the distribution of Cu (II) in magnesium hydroxide precipitate: In an Mg:Cu ratio of 1:0.001, Cu (II) is in the magnesium hydroxide phase in the form of isolated monomeric paramagnetic particles. The EPR spectrum of each of these particles is characterized by a spin hamiltonian corresponding to the axial symmetry of the paramagnetic particles. Regardless

of actual pH, two types of monomer particles coexist in the pH interval from 10 to 14. Form 1 has the parameters of an EPR spectrum coinciding exactly with that obtained previously for the mechanical mixture $Zr(OH)_4-Cu(OH)_2$ and thus represents a hydroxide of divalent copper that is evenly distributed throughout the magnesium hydroxide precipitate. As the Cu (II) content in the magnesium hydroxide phase increased and reached some threshold concentration (approximately Mg:Cu = 1:0.001), a magnetic dipole-dipole interaction between adjacent copper ions and the formation of two types of polynuclear particles (clusters) was observed. As the temperature was reduced to 77 K, the intensity of these lines increased sharply, a phenomenon that was linked to an increase in the fraction of paramagnetic clusters. The presence of paramagnetic Cu complexes in magnesium hydroxide was explained in terms of both its crystalline structure and its formation process. The greatest coprecipitation was observed to occur at an Mg:Cu ratio between 15:1 and 1:1. Further increasing the ratio resulted in a decrease in coprecipitation at all pH levels, a finding that was linked to the formation of soluble cuprates. X-ray crystallographic analysis revealed that at the aforesaid Mg:Cu ratios, coprecipitation results in a reduction in crystallite sizes by a factor of 2 to 3 and the formation of finely dispersed precipitates with a crystallite size of about <50 angstroms. Additional studies revealed that the process of the entry of Cu (II) hydroxo complexes in the microconcentration range also occurs in the macroconcentration range. What is evidently occurring is the simultaneous formation of the skeleton of the crystalline lattice of magnesium hydroxide and the filling of its interlayer spaces with hydroxo complexes of Cu (II). Analysis of the IR spectra of specimens with Mg:Cu ratios of 15:1, 1:1, and 1:2 revealed that the spectra of the latter differ from the spectra of hydroxides of magnesium and copper and their mechanical mixtures and that they represent the spectrum of a complex compound. Findings regarding individual bands identified in the said spectra are discussed. Figures 2, tables 2; references 19: 14 Russian, 5 Western.

An Electrofiltration Method of Producing Highly Pure Water

927M0056G Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 4, Jul-Aug 91 (manuscript received 23 Apr 90) pp 156-161

[Article by L.N. Moskvina, L.A. Godon, V.S. Gurskiy, and L.V. Yepimakhova, Technology Scientific Research Institute, Leningrad Oblast; UDC 66.063:543.3]

[Abstract] In most cases the final stage in the deep purification of water is ion exchange deionization followed by microfiltration through membranes with pore diameters of 0.1 to 0.22 μm . The problem with this process is that the same ion exchange resins that remove ionic impurities from the water are themselves a source of contamination of the water with products of the resin's destruction. One alternative for the final treatment of water that is free of the drawbacks of ion exchange deionization is a reagent-free electro-osmosis process. The authors of the study reported herein conducted a series of experiments to verify

the effectiveness of the electrofiltration method of deep-cleaning water. They used an electrofiltration circuit that included a microfiltration membrane and Pt electrodes. The experiments were conducted in solutions of cesium chloride, as well as sodium chloride, hydroxide, and picrate tagged with ^{137}Cs and ^{22}Na radioactive markers. Millipore (United States) cellulose acetate membranes with pore diameters of 0.8 and 1.2 μm and a porosity of 75% were used along with fluoroplastic membranes that were manufactured by the pressing and subsequent annealing of polymerization polytetrafluoroethylene powder and that had a porosity of 35% and an average pore diameter of 2 to 5 μm . The tests conducted confirmed that the electrofiltration method is indeed feasible for use in deep-cleaning water at a rate of up to 15 l/h. The study data were then used as the basis for manufacturing an electrofiltration unit containing a polytetrafluoroethylene membrane with a diameter of 170 mm and a working area of 200 cm^2 mounted in a fluoroplastic filter press-type cell. Tests of the proposed electrofiltration process on the newly constructed filtration unit confirmed that from the standpoint of ion impurity content, the quality of water purified by electrofiltration is highly competitive with that purified by ion exchange deionization. The new electrofiltration process did initially pose some problems in that water treated by the new process was inferior to water treated by the ion exchange deionization process from an electric conduction standpoint. This problem was remedied by correcting the pH of the starting water, however. Figures 4, tables 3; references 6 (Russian).

Selected Structural Sources of the Embrittlement of High-Purity Polycrystalline Tungsten

927M0056H Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 4, Jul-Aug 91 (manuscript received 11 Dec 90) pp 199-203

[Article by B.A. Gnesin, V.G. Glebovskiy, M.I. Karpov, V.V. Kireyko, and A.A. Snegirev, Solid-State Physics Institute, USSR Academy of Sciences, Chernogolovka; UDC 621.745:621.771]

[Abstract] Removing impurities, particularly oxygen and carbon, from polycrystalline tungsten is one of the most effective ways of improving its plasticity. The Solid-State Physics Institute of the USSR Academy of Sciences has developed a technology for producing melted tungsten blanks and then pressing and rolling them. The new technology was developed in view of the fact that the embrittlement of tungsten results from two main sources that are directly connected with interstitial impurities entering into tungsten during the rolling process and remaining in the tungsten even after significant hot deformations and intermediate annealings to 2,300°C. The tungsten was subjected to hot pressing with a relative deformation of 70 to 78%. Hot rolling was performed on a DUO-300 duo mill. Before rolling, the blanks were heated in a hydrogen furnace. The dew point of the hydrogen fed into the furnace was not allowed to rise above -30°C. In ingots up to 120 mm in diameter, pores were present in a layer up to 15 mm from the surface. When used on

high-purity tungsten with a normal density, the new process made it possible to successfully roll sheets with a thickness of 1.2 to 1.5 mm. Under the same process conditions, tungsten with a lower-than-average density could only be rolled into sheets 2 to 4 mm thick. Studies performed by using the aforesaid pressing and rolling process on tungsten specimens with different initial densities and impurity contents revealed that hydrogen passing from the atmosphere of the hydrogen furnace and into the tungsten during the heating process before the actual rolling is one possible cause of embrittlement of highly pure tungsten. Another possible cause of embrittlement is the entry of oxygen into the sheets from surface oxides. This may occur despite the practice of heating in a reducing atmosphere before rolling. Reducing the amount of time for which the heated tungsten sheets are in air (i.e., reducing the number of passes) and reducing the heating temperature were recommended as ways of reducing contamination of the tungsten with oxygen. Figures 2; references 3 (Russian).

The Effect of Doping on the Formation of a Monocrystalline Structure in Tungsten Wire During Recrystallization Annealing

927M0056I Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 4, Jul-Aug 91 (manuscript received 18 Jan 91) pp 204-209

[Article by G.S. Burkhanov, Ye.V. Ottenberg, A.N. Mironicheva, V.V. Khaydarov, S. Kim, Yu.V. Aleynikov, and I.P. Kuritnykh, Metallurgy Institute imeni A.A. Baykov, USSR Academy of Sciences, Moscow; UDC 669.018.45-175]

[Abstract] The authors of the study reported herein examined the effect that microdoping with thorium and yttrium oxides, rhenium, and aluminosilicon alkalines have on grain growth and on the formation of a monocrystalline structure in tungsten wire during recrystallization annealing. Tungsten wire 0.3 to 0.5 mm in diameter was used as the starting material. Specimens of tungsten wire that had not been doped were compared with specimens to which varying amounts of the aforesaid dopants had been added. The specimens were subjected to isothermal annealing in a vacuum in the temperature range from 1,200 to 1,900°C for 1 hour. The vacuum during the annealing process was not allowed to deteriorate below 133×10^{-5} Pa. The temperature of the initiation of recrystallization was between 1,100 and 1,500°C for all the specimens. Tests performed on the study specimens demonstrated that the aluminosilicate alkalines and thorium oxides yielded the best results. Yttrium oxides were discovered to have only a small beneficial effect, and the rhenium doping was actually found to retard the formation of a monocrystalline structure. Analysis of the kinetics of grain growth in tungsten wire during annealing demonstrated that in order to achieve a monocrystalline structure, the annealing must be implemented at very high temperatures. The optimal annealing temperature at an annealing speeds of 2.5, 0.9, and 4 cm/min was determined to be between 2,100 and 2,600°C. The maximum length of monocrystals grown in type VA tungsten wire was found to

be between 5 and 10 mm. A pseudo-monocrystalline structure was observed in longer segments of wire. Figures 4, table 1; references 10: 9 Russian, 1 Western.

Investigation of the Reasons for Embrittlement of Molybdenum Used in Electronics Products

927M0056 Moscow VYSOKOCHISTYYE
VESHCHESTVA in Russian No 4, Jul-Aug 91
(manuscript received 13 Feb 91) pp 214-219

[Article by G.S. Burkhanov, Ye.V. Krasnovskaya, V.S. Predmirskiy, V.B. Bessonov, Ye.V. Ottenberg, B.V. Markin, S.M. Mikhaylov, and R.Yu. Kozlov, Metallurgy Institute imeni A.A. Baykov, USSR Academy of Sciences, Moscow; UDC 621.385.632]

[Abstract] MLZVP molybdenum wire, which has an elevated embrittlement temperature and is made of molybdenum monocrystals doped with microquantities of zirconium and titanium, has been used successfully in the manufacture of spirals for vacuum tube products. It has recently been plagued with quality problems, and its quality has been found to vary greatly from batch to batch and even within batches. In view of these facts, the authors of the study reported herein examined the reasons for the embrittlement of MLZVP wire when used in electronics products. Defective pieces of MLZVP molybdenum wire were subjected to gas analysis, x-ray spectral microanalysis, electron microscopy studies, and metallographic analysis. Studies of the microstructure of the defective spirals revealed their inhomogeneity: "Islands" of large grains were visible against the background of the wire's fine-grained microstructure. Accumulative recrystallization had thus occurred in individual segments of the wire. This difference in grain size was hypothesized to be the consequence of the nonuniformity of the wire's chemical makeup. This hypothesis was confirmed by x-ray spectral microanalysis, which revealed (1) the uneven distribution of the zirconium and titanium dopants used in the wire and (2) the presence of Si-, Al-, K-, Ni-, Ca-, Cu-, and Fe-based microimpurities that were present in the starting material and unevenly distributed throughout it. Figures 3, tables 2; references 10 (Russian).

The Strength of IR Fiber Lightguides Made of High-Purity Chalcogenide Glasses

927M0056K Moscow VYSOKOCHISTYYE
VESHCHESTVA in Russian No 4, Jul-Aug 91
(manuscript received 18 Jan 91) pp 220-225

[Article by V.F. Chuprakov, V.V. Sakharov, N.M. Kononova, E.N. Loytsker, G.Ye. Kharitonova, and I.A. Baryshnikov, Vacuum Tube Glass Scientific Research Institute and Plant, Moscow; UDC 546.19(22+23).6-484+539.412.1]

[Abstract] The authors of the study reported herein examined the strength characteristics of infrared fiber lightguides made of As_2Se_3 arsenic selenide glass, As_2S_3 arsenic sulfide glass, and other glasses based on the system As-S- Se . The strength characteristics of the said lightguides were studied under conditions of dynamic tensile loading (at a constant rate of 5 mm/min) and flexural loading (by

measuring the minimum radius of bending at which the lightguide fractures). The fracture tests were conducted on specimen IR lightguides 0.35 mm in diameter and 40 mm long with no protective sheathing and on specimens of the same dimensions that had been coated with a sheathing of F-42L fluoroplastic 10 μ m thick. A standard 2055R-0.5 tensile testing machine was used for the experiments. The flexural strength tests were performed on specimens at least 250 mm long. The measurements obtained were analyzed by using Weibull statistics and the weakest-link model. After analyzing the test results, the researchers concluded that the strength and ultimately the durability of chalcogenide glass-based lightguides is largely determined by the quality with which they were manufactured. The strongest and most durable IR lightguides were those that were free of defects and cracks both inside and out and that had a high-quality protective coating increasing the strength of their glass by 5 to 10%. Extended storage (at least 20,000 hours) of the lightguides at room temperature did not appear to reduce their durability. Figures 5, table 1; references 6: 3 Russian, 3 Western.

Intensifying the Process of Purifying Si Rods by Induction Crucible-Free Zone Melting

927M0057A Moscow IZVESTIYA AKADEMII NAUK
SSSR: SERIYA NEORGANICHESKIYE MATERIALY
in Russian Vol 27 No 5, May 91 (manuscript received
29 Aug 89) pp 887-889

[Article by Yu.V. Trubitsyn, K.N. Neymark, I.F. Chervonnyy, and E.S. Falkevich, Zaporozhye Titanium-Manganese Combine imeni 60th Anniversary of the Great October Socialist Revolution; UDC 548.65]

[Abstract] In an effort to intensify the process of purifying silicon rods by induction crucible-free zone melting, the authors of the study reported herein examined that effect that speed of shifting the zone and frequency of the current feeding the inductor have on the said process. As their criterion for evaluating the intensity of purification as a function of variations in the process parameters of crucible-free zone melting the authors selected the experimentally determined purification coefficient m , which includes the effects of both segregation and vaporization of the impurities in the silicon. The value of m was found as the ratio of the average values of the specific electrical resistance of the starting and recrystallized rods. Distortions of the results due to the presence of rapidly diffusing impurities (specifically, aluminum) were eliminated by a preliminary forming pass of the molten zone along the study rods in which the said impurities were removed. The value of the coefficient m was determined during the crucible-free zone melting of silicon rods measuring 30 mm in diameter on a Kristall 109 unit in a vacuum at a residual pressure not exceeding 1.3×10^{-4} Pa. The purification was implemented at speeds of shifting the melt zone ranging from 1 to 5 mm/min and an induction heater currents of 1.76, 2.8, and 5.28 MHz. At these induction heater current intensities, the intensity of purification was increased by factors of 1, 1.4, and 1.7, respectively. This intensification of the purification process is explained in terms of the dual nature of the effect of the work coil's electromagnetic field

on the mass transfer processes in the melt zone: The electromagnetic field causes a mechanical effect on the melt in a radial direction (perpendicular to the axis of the silicon rod), on the one hand, and a magnetohydrodynamic effect in the plane perpendicular to the plane of the work coil (in the direction of the magnetic induction vector). The sum of these two effects of the electromagnetic field on the melt is a linear function of frequency, which explains the increase in intensity of purification as the frequency of the feed current is increased. Reducing the speed at which the melt zone is shifted is shown to have an analogous effect. Figure 1; references 6 (Russian).

Deposition of Pyrolytic Aluminum Oxide Films Onto Si, GaAs, and InP

927M0057B Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 4 Jul 89) pp 893-896

[Article by O.N. Mittov, S.V. Fetisova, T.A. Gadebskaya, I.I. Nevryuyev, and B.L. Agapov, Voronezh State University imeni Lenin Komsomol; UDC 546.623'21:539.216.2]

[Abstract] The authors of the study reported herein examined the composition and structure of thin aluminum oxide films precipitated from the gaseous phase by pyrolysis of aluminum tris-acetylacetonate in an oxidizing medium at low temperatures and then deposited onto various semiconductor substrates. KEF-7.5 (111), AGP1 GaAs (100), and FIEO-2 (100) InP prepared in accordance with the standard methods served as substrates. The anhydrous aluminum acetylacetonate was purified in a chromatographic column before being used. The films were precipitated in a two-zone continuous horizontal reactor with resistive heating. The temperature in the vaporization zone was kept at 240°C, and the temperature in the precipitation zone was kept at either 350, 400, 450, or 500°C. Argon (fed in at a rate of 18 l/h) was used as a carrier gas. Air was fed in at a rate of 5 l/h to promote more complete oxidation of the Al(AcAc)₃. The oxide films were etched in hydrofluoric acid (concentration, 0.6 mol/l). The composition of the films produced was determined by x-ray microanalysis in a regimen using an accelerating voltage of 10 to 15 kV and a probe current of 1×10^{-9} A. The statistical error in determination of concentration ranged from 0.25 to 0.32%. The average film precipitation rate depended on the temperature and type of substrate. At temperatures of 350, 400, 450, and 500°C, the films were deposited onto Si at rates of 1, 3, 5, and 12 nm/min, respectively. At the same temperatures, the rates of deposition onto GaAs substrates were 1, 3, 5, and 18 nm/min, respectively, and the rates of deposition onto InP substrates were 33, 34, 45, and 80 nm/min (which is 5 to 30 times faster than in the cases of Si and GaAs substrates). The studies performed indicated that during pyrolysis of Al(AcAc)₃ in an oxidizing medium, the destruction of the starting compound begins in a layer of vapor on the film's surface and culminates in its upper layer (about 8 nm thick). Pyrolytic films of aluminum oxide deposited onto various semiconductor bases without additional annealing turn out to consist of three layers. The main mass of the

film is in the middle layer, which is close to stoichiometric Al₂O₃ in composition. The transition layer at the film-substrate interface (about 20 nm thick) consists of aluminum, oxygen, and the substrate components. It is this layer that essentially determines the differences in the chemical makeup of the films deposited onto different substrates. Figures 3, table 1; references 3: 2 Russian, 1 Western.

Accelerated Formation of Oxide Dielectric Layers Onto GaAs in the Presence of V₂O₅ in the Gaseous Phase

927M0057C Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 12 Jul 89) pp 897-900

[Article by I.Ya. Mittova, V.V. Sviridova, V.N. Semenov, and T.N. Kuznetsova, Voronezh State University imeni Lenin Komsomol; UDC 546.681'19:542.943]

[Abstract] The authors of the study reported herein examined the effect that the gaseous-phase addition of V₂O₅ during the process of forming gallium arsenide-based dielectric layers has on the growth rate and kinetics of the formation of the said layers and on the makeup and properties of the resultant films. Type SAGOCh-1 gallium arsenide films with a (111) orientation and with a resistivity of 0.01 to 0.018 ohm-meters were used during the experiments. The wafers were subjected to preoxidizing treatment in HF (49%) for 20 minutes. The dopant V₂O₅ (with a grade of pure and conforming to specification [TU] TsM-4566-55) was added to a corundum crucible covered with an oxidizable plate. The oxide layers were formed under straight-through conditions (with oxygen as the oxidizing agent) in a furnace with resistive heating. The temperature was varied from 500 to 600°C (it was regulated with a precision of $\pm 2^\circ\text{C}$). The layers were built up in times ranging from 5 to 70 minutes, and their thickness was measured by the ellipsometric method. The oxide layers grown in gallium arsenide to which V₂O₅ had been added were thicker than standard specimens of the same grade that were oxidized under the very same conditions but without the addition of the V₂O₅. Adding V₂O₅ was found to increase the layers' thickness by a factor of 4 on average and by a factor of 6 in the maximum case. Adding V₂O₅ to the gaseous oxidizing phase also accelerated the film formation process (by a factor of 8 in the maximum case) and did so without noticeably affecting the characteristics of the resultant films. Figures 2, tables 2; references 11: 6 Russian, 5 Western.

Optical Diagnosis of Thin CdS Films Produced by the Method of Electron Beam Vaporization

927M0057D Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 28 Jun 89) pp 901-904

[Article by S.V. Bogdanov, V.T. Volkov, I.V. Maslennikov, and A.N. Pronin, Institute of Problems Related to the

Technology of Microelectronics and Ultrapure Materials, USSR Academy of Sciences; UDC 537.311.322]

[Abstract] The authors of the study reported herein examined the effect that electron beam vaporization regimens and subsequent annealing have on the optical properties of polycrystalline CdS films in the exciton range. Their purpose in so doing was to optimize the technology of producing thin CdS semiconductor films for use in creating the matrices of optronic information receiving and processing elements. The study CdS films were produced in a vacuum chamber with the oilless evacuation method. The residual gas pressure before the sputtering was 10^{-5} Pa. The films were sputtered onto substrates of fused quartz that had first been rinsed with isopropyl alcohol and then etched in argon plasma. Before the sputtering, the substrates were heated directly in a vacuum chamber at 600°C for 1 hour. The resultant films were annealed in a vacuum chamber in a copper container with a stopper. Before the annealing, some of the specimens were coated with a layer of SiO_2 about $0.2\ \mu\text{m}$ thick to prevent vaporization of the film components. The study films were placed in a helium cryostat at a temperature of 5 K and were subjected to photoluminescence excited by an LGK-504 helium-cadmium laser with a wavelength of 441 nm and a power of 300 mW. A KGM-10-100 lamp was used to measure the transmission spectra. During the sputtering, the film thickness was kept constant at $1 \pm 0.1\ \mu\text{m}$, and the flow of vaporized matter was kept at $10^{-6}\ \text{g/cm}^2\text{-s}$. The substrate temperature was varied as were the annealing time and temperature. The experiments performed showed that the decisive factor in the production of high-quality CdS films on fused quartz is the temperature of the substrate during sputtering. The studies also confirmed that the distinct exciton structure in the transmission and luminescence spectra of the films arises only after annealing. The concentration of electrically active defects of the best specimen produced was $6 \times 10^{17}/\text{cm}^3$. The properties of the free and substrate sides of the films produced were noticeably different from one another: from the substrate side, the density of both the acceptor-type defects and the centers of radiationless recombination was much lower. Figures 4; references 9: 6 Russian, 3 Western.

The Thermoelectric Properties of a Solid Solution of $\text{Bi}_{1.6}\text{Sb}_{0.4}\text{Te}_3$ Grown by Zone Recrystallization

927M0057E Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 10 Jul 89) pp 922-928

[Article by A.A. Ayvazov, A.I. Anukhin, A.I. Mazina, and N.A. Boboshko, Moscow Electronics Technology Institute; UDC 621.315.592]

[Abstract] The authors of the study reported herein examined the thermoelectric properties of a solid solution of $\text{Bi}_{1.6}\text{Sb}_{0.4}\text{Te}_3$ grown in by vertical zone melting from a charge containing an excess (2 atomic percent above the stoichiometric amount) of tellurium. The study alloys were prepared from elementary Bi, Sb, and Te in graphitized quartz ampules. The length of the finished ingot was 5 to 6

times the length of the melt zone. For the studies of the thermoelectric properties of the materials grown, the entire ingot was cut into specimens $3 \times 3 \times 5\ \text{mm}$ in size. Metallographic studies performed on the study specimens revealed that ingots of solid solutions of $\text{Bi}_{1.6}\text{Sb}_{0.4}\text{Te}_3$ consist of a single phase virtually throughout their entire length. At region about 15 mm long at the end of the ingot was observed to consist of two phases and have a layered structure. The two- and single-phase regions had a sharply pronounced interface indicating the suddenness of the appearance of two-phase crystallization. The distribution of the thermoelectromotive force coefficient throughout the ingot was characterized by a change in sign from positive to negative. The curve of the ingot's resistivity consisted of an initial, practically linear decrease in the ingot's resistivity followed by a sharp bend indicating an inversion point, which was in turn followed by a linear increase. The slope of the broken line relative to the abscissa in the region of p-type solid solutions was approximately twice that in the region of the n-type solid solutions. The curve of the distribution of thermoelectric efficiency along the ingot was observed to contain two maxima separated by a deep minimum. The position of this minimum on the ingot corresponded to the inversion of the sign of the thermoelectromotive force coefficient. The temperature course of the thermoelectromotive force coefficient for p- and n-type solid solutions had a maximum whose position on the temperature axis was found to depend on the point in the ingot form where the specimen was cut. In the beginning of the ingot, the electric conductivity of the $\text{Bi}_{1.6}\text{Sb}_{0.4}\text{Te}_3$ solid solution decreased rapidly as the temperature increased. Closer to the point of the inversion in the sign of the main charge carriers, the drop in conductivity became less rapid. At the actual point of the change in sign, the conductivity began to increase with temperature. In that portion of the ingot with electronic conduction, the sharpest drop in conductivity of the solid solution as the temperature increased was observed to be toward the end of the ingot. The metallographic studies performed showed that the nature of the distribution of the thermoelectric properties of $\text{Bi}_{1.6}\text{Sb}_{0.4}\text{Te}_3$ solid solutions along the ingot is not related to two-phase crystallization. Rather, the temperature dependences of the thermoelectric properties along the length of the ingot were found to be explainable in terms of the processes occurring during zone recrystallization at the melt-solid interface. In other words, it is microliquation that appears to be the main factor governing the temperature dependence of the parameters of $\text{Bi}_{1.6}\text{Sb}_{0.4}\text{Te}_3$. Figures 4; references 8: 4 Russian, 4 Western.

The Structure of the Alloy $\text{Bi}_{0.52}\text{Sb}_{1.48}\text{Te}_3$ Produced by Hardening From a Liquid State

927M0057F Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 21 Jul 89) pp 929-932

[Article by O.Sh. Gogoshvili, G.G. Kononov, S.P. Krivoruchko, I.P. Lavrinenko, and I.I. Ovsyanko, Sukhumi Physics Technology Institute imeni Academician I.N. Venua; UDC 537.311]

[Abstract] The authors of the study reported herein examined the characteristic features of flakes formed during the centering of $p\text{-Bi}_{0.52}\text{Sb}_{1.48}\text{Te}_3$ and the structural state of compact specimens formed by hot compaction of the flakes. The study alloy was synthesized by superfast hardening in an induction heating unit. At a temperature of 1,000 to 1,050 K, the melt was poured onto the inner surface of a massive copper cylinder. The hardening rate was estimated at 10^6 K/s. Compact specimens were produced by subjecting the flakes to hot compaction under a pressure of 38 MPa for 15 minutes at temperatures of 600 and 800 K. The thermoelectromotive force coefficient and resistivity of the pressed specimens were measured by the compensation method with a precision of 5 and 3%, respectively. The heat conduction coefficient was determined by the absolute method (precision, 8-10%) under conditions of a stationary heat flux. The microstructure of the study flakes was analyzed by using a METAM R-1 light microscope, and the microstructure of the pressed specimens was studied by light microscopy of sections taken parallel to the direction of the compaction force. The sections were subjected to electric polishing in a solution of 68 g tartaric acid and 68 g KOH in 850 ml water at a current density of about 0.3 A/dm². The specimens were also subjected to x-ray analysis on a DRON-3 diffractometer. The superfast hardening as described above resulted in flakes no more than 40 μm thick and spherical particles ranging from 40 to 2,000 μm in diameter, with the latter accounting for 25 to 30% (by mass) of the material form. The microstructure of the spherical particles could be described as chaotically growing acicular crystallites. The flakes' surface structure was found to be determined by the conditions of heat release during crystallization. The flakes' free surface was wavy with an acicular microstructure, whereas the microstructure of those flake surfaces that came into contact with the crystallizer could be characterized as fine-grained, with the profile of the surface repeating that of the crystallizer. Columnar crystallites growing from the surface that had been in contact with the crystallizer were the characteristic structural elements of the flakes. Changes in the conditions of heat release throughout a flake's thickness as it was crystallized resulted in a change in the habit of the crystallites formed and caused their major axis to turn somewhat. The flake surfaces that had been in contact with the crystallizer had two texture axes, i.e., (001) and (205), with 25 and 35% of the grains in each of these respective orientations. Only one direction of predominant orientation, i.e., (110), was discovered on the free surface of the flakes, and about 50% of the crystallites had that orientation. A significant reorientation of the crystallites throughout the flakes' thickness was observed and was concluded to be the main reason why the pressed specimens formed by compacting the flakes were practically isotropic. The pressed specimens were found to have a dense flake packing (i.e., a relative porosity of less than 0.1%). Compaction at 800 K induced changes in both the structure and properties of the specimens. Specifically, the compaction resulted in partial recrystallization and development of texture (015), albeit weak. The sign of the anisotropy of the specimens resistivity also changed. Figures 3; references 7 (Russian).

An Investigation of Electrical Resistance of Low-Temperature Powdered Solder

927M0057G Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 26 Jul 89) pp 979-982

[Article by L.G. Gribnyak, E.M. Denga, and V.K. Marinchik, Odessa Communications Electrical Engineering Institute imeni A.S. Popov; UDC 621.762.242:537.311]

[Abstract] The authors of the study reported herein attempted to estimate selected parameters of oxide films on the surface of grains of powdered solder produced by the method of emulsification in a shape-forming organosilicon fluid. They did so by conducting temperature studies of the resistance and volt-ampere characteristics of the said powders. For their studies, the researchers used spherical powder grains ranging from 4 to 6 $\times 10^{-2}$ mm in diameter. Three types of solder were used: POS-61 with an emulsification temperature of 204°C, POS-61 with an emulsification temperature of 268°C, and POSK 50-18. The studies performed revealed that powdered low-temperature tin-and-lead solders produced by emulsification in an organosilicon protective fluid at 200°C or below have an oxide film about 10 angstroms thick on their surface. The temperature dependence of the resistance of such powder is linear because of the temperature dependence of the solder alloy and the tunnel nature of the conduction of the gaps between its grains. In the case of solders made of such powders, the powdered solder does not have any noticeable effect on the degradation of solder paste while it is in storage. Type POS-61 powdered solder produced by emulsification in a protective fluid at 268°C, on the other hand, has a rather thick oxide semiconductor-like layer on its surface that is decisive to the temperature dependence of the powder's resistance. This thick layer does affect the degradation of solder paste during storage. Figures 4, table 1; references 5 (Russian).

The Effect of Crystalline Structure on the Luminescence of Solid Solutions of the System $\text{Y}_2\text{O}_3\text{-Gd}_2\text{O}_3\text{-La}_2\text{O}_3$

927M0057H Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 2 Aug 89) pp 988-991

[Article by A.O. Dmitriyenko, T.A. Akmayeva, N.V. Rudneva, and A.F. Bolshakov, Saratov State University; UDC 535.37]

[Abstract] The authors of the study reported herein examined the effect of crystalline structure on the luminescence of crystal phosphors based on ternary solid solutions of the system $\text{Y}_2\text{O}_3\text{-Gd}_2\text{O}_3\text{-La}_2\text{O}_3$. The phosphors were synthesized by completely dissolving the three starting compounds in nitric acid (concentration, 1.2 g/cm³). The pH was brought to 2.0 by adding an ammonia solution. Next, rare earth element oxalates were coprecipitated by using a saturated solution of oxalic acid. The precipitates were filtered off, rinsed with cold distilled water, and dried at

80°C for 6 hours. The mixtures were transferred to quartz crucibles and annealed in at 1,000°C for 12 hours. After annealing, the mixtures were hardened in air at room temperature. The activator Eu_2O_3 was added in the form of a nitric acid salt. The content of activator (as calculated for Eu_wO_3) was varied from 2.5 to 10 mol%. A DRON-2.0 diffractometer was used to perform x-ray studies of the annealing products, and the spectra of the excitation of the specimens' integral photoluminescence were recorded on a Specord M 40 spectrometer in the range from 210 to 350 nm, and the photoluminescence spectra were recorded on a luminescence photometer with a KGM-100 lamp serving as the excitation source. A UFS-2 light filter was used to obtain radiation with a maximum wavelength of 330 nm. X-ray phase analysis of the annealing products confirmed that ternary solid solutions in the concentration ranges of the members of the ternary system studied crystallize primarily in a C-structure. The H and M phases of the solid solutions form in mixtures enriched with lanthanum oxide. A hexagonal phase without impurities of other phases was obtained only in the case of solid solutions containing more than 90 mol% La_2O_3 . A pure M-phase could not be produced under the aforesaid experiment conditions. Adding an activator did not alter the phase ratios of the crystal phosphor's matrix. The studies revealed that 10 mol% is the optimal amount of activator regardless of the composition of the matrix. The structure of the photoluminescence spectra was found to be determined by the type of crystal phosphor structure. The position of the maxima of the bands in the spectra of phosphors with different crystal structures was found to be determined by the symmetry of the positions of the ion activator. The effective distance of excitation energy transfer in crystal phosphors based on solid solutions of the study ternary system was found to amount to about 0.6 nm. Figures 4; references 4: 2 Russian, 2 Western.

The Diffusion of Gold in Silicon During Neutron Irradiation and Pulsed and Stationary Annealing

927M00571 Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 5, May 91 (manuscript received 6 Jul 89) pp 1079-1080

[Article by T.P. Svistelnikova, T.V. Moiseyenkova, F.I. Korshunov, N.A. Sobolev, and V.A. Kharchenko, Obninsk affiliate, Physical Chemistry Institute imeni L.Ya. Karpov, and Solid-State and Semiconductor Physics Institute, Belarus Academy of Sciences; UDC 546.28.59]

[Abstract] The authors of this concise report examined the diffusion of gold in silicon during neutron irradiation and pulsed and stationary annealing. Disks of dislocation-free monocrystalline n-type silicon that measured 20 mm in diameter and 3 mm in thickness and that had a resistivity between 200 and 300 ohm-cm and a nonequilibrium charge carrier lifetime of 300 to 400 μs were chemically polished and rinsed in an acid-and-peroxide solution. Next, one drop of nitrohydrochloric acid containing 1.2×10^{-8} g dissolved gold was applied to one side of each disk. The specimens were sealed in pure quartz ampules and irradiated at a fluence of 6×10^{18} neutrons/cm² with a 10:1 ratio

of slow and fast neutrons. Then, the first batch of specimens was subjected to heat treatment for 2 hours at 820°C to anneal the radiation defects. The second batch of specimens was annealed in air by pulsed radiation from halogen incandescent lamps with a pulse duration of 10 seconds at an induced temperature of 880°C. In their examination of the pulse-annealed neutron-irradiated silicon, the researchers did not observe any increase in the coefficient of the diffusion of the gold that had been adsorbed on the surface of the silicon before the irradiation. Nor did they observe any increase in the concentration of the said gold that was diffused into the bulk of the silicon. Further analysis led the researchers to conclude that the same conclusion would be all the more valid for rapidly diffusing dopants with lower coefficients of diffusion in silicon than that of gold. This led them to infer that when pulsed annealing is used during the nuclear doping of silicon, there is no need for the deep purification of the silicon surface directly before pulsed annealing that is required before thermal annealing. References 10: 8 Russian, 2 Western.

The Effect of Germanium on the Diffusion of Oxygen in Monocrystalline Silicon

927M0058A Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 7, Jul 91 (manuscript received 3 Nov 89) pp 1333-1336

[Article by D.N. Korlyakov, Moscow Steel and Alloys Institute; UDC 546.28]

[Abstract] The authors of the study reported herein examined the effect of germanium on the diffusion of oxygen in monocrystalline silicon. Dislocation-free monocrystals of silicon and germanium-doped silicon ($N_{\text{Ge}} = 10^{20} \text{ cm}^{-3}$) were studied. Both were grown by the Czochralski method under identical conditions in the direction (111) and doped with phosphorus ($N_{\text{P}} = 6 \times 10^{13} \text{ cm}^{-3}$). The oxygen and carbon concentrations in the study monocrystals amounted to $5.5\text{-}6 \times 10^{17}$ and $4\text{-}6 \times 10^{16} \text{ cm}^{-3}$, respectively. Each of the study monocrystals was heat-treated in a vacuum under one of the following temperatures (K): 620, 645, 670. Before the physical properties of each specimen were measured, a layer approximately 50 μm thick was removed from it. Germanium was found to retard the formation of heat donors in silicon. This phenomenon was said to likely be due to a reduction in the coefficient of oxygen diffusion in the silicon. The diffusion of oxygen in germanium-doped silicon was found to be anomalously rapid. It was hypothesized that at low temperatures, oxygen diffusion occurs in accordance with a mixed diffusion mechanism. Then, at temperatures between 570 and 770 K, oxygen transfer likely occurs through moving metastable vacancy-oxygen (V-O) complexes. The authors further discovered that in germanium-doped silicon monocrystals (as opposed to non-germanium-doped monocrystals), the activation energy of oxygen diffusion is closer to the activation energy of oxygen diffusion in silicon in accordance with an interstitial mechanism. This

finding is explained, and a model of the effect of germanium on processes of oxygen diffusion in silicon is proposed. Figure 1, tables 2; references 9: 1 Russian, 8 Western.

Highly Doped Silicon Layers Grown From a Molecular Beam in a Vacuum

927M0058B Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 7, Jul 91 (manuscript received 27 Nov 89) pp 1337-1341

[Article by V.P. Kuznetsov, A.Yu. Andreyev, O.A. Kuznetsov, L.E. Nikolayeva, T.M. Zotova, and N.V. Gudkova, Gorkiy State University imeni N.I. Lobachevskiy and Physics Technology Scientific Research Institute; UDC 539.234:546.28]

[Abstract] The authors of the study reported herein examined the possibility of producing thin, high-doped silicon layers in an epitaxy process without any extraneous actions. Layers of silicon were grown in a vacuum of 5×10^{-6} Pa on substrates of Si (001). Si wafers doped with antimony ($6 \times 10^{18} \text{ cm}^{-3}$), phosphorus ($1 \times 10^{19} \text{ cm}^{-3}$), arsenic ($2 \times 10^{19} \text{ cm}^{-3}$), or aluminum ($1.5 \times 10^{19} \text{ cm}^{-3}$) were used as Si and dopant vapor sources. The epitaxy temperature ranged from 500 to 770°C, and the growth rate ranged from 0.2 to 5 $\mu\text{m/h}$. Layers between 30 and 100 nm thick were grown. The Hall layer was used to perform a layer-by-layer analysis of the study specimens. The maximum values of the concentration of current carriers in the doped layers were as follows: phosphorus, $2 \times 10^{20} \text{ cm}^{-3}$; arsenic, $1.9 \times 10^{20} \text{ cm}^{-3}$; antimony, $1.3 \times 10^{20} \text{ cm}^{-3}$; and aluminum, $1.5 \times 10^{19} \text{ cm}^{-3}$. The concentration of electrically active antimony in the layers produced exceeded the threshold of its solubility in silicon at 500° ($4 \times 10^{19} \text{ cm}^{-3}$). No conclusions could be reached regarding the solubility thresholds of aluminum, phosphorus, or arsenic. While several of the Si<As> layers were being grown, the source melted on the surface and then solidified. Measurement of the Hall constant in layer-by-layer etching (30 nm each) revealed that the concentration of carriers in the layers ranged from 1.7×10^{20} to $8 \times 10^{18} \text{ cm}^{-3}$, which coincided with the arsenic concentration in the source. Thin, high-doped layers were deposited in 1 minute or less. More complex structures generally took a longer time (by several orders of magnitude). The concentration of current carriers in the highly doped layers was found to change only slightly after annealing. Because of this, the authors concluded that it is possible to forecast and maintain a high level of doping of individual regions of a complex silicon structure grown over a protracted period of time. Figures 2; references 25: 10 Russian, 15 Western.

The Initiating Dopant Distribution Coefficient and Its Effect on the Electric Resistance of Whisker Crystals of Silicon

927M0058C Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 7, Jul 91 (manuscript received 7 Dec 89) pp 1342-1344

[Article by A.A. Shchetinin, V.A. Nebolsin, O.D. Kozenkov, A.F. Tatarenkov, A.I. Dunayev, and Ye.P. Novokreshchenova, Voronezh Polytechnic Institute; UDC 548.55]

[Abstract] The primary objective of the study reported herein was to determine the effective coefficient of the distribution of initiating dopant in whisker silicon crystals and to determine the effect of the said coefficient on the silicon crystals' electrical resistance. Whisker silicon crystals were grown in a standard chloride system at temperatures ranging from 1,300 to 1,450 K in accordance with a method described elsewhere as well as by reducing silicon from its zinc tetrachloride at 1,000-1,100 K. Particles of gold and copper were used as dopants initiating one-dimensional vapor-liquid-crystal growth. Types EKDB, EKEF, and EKES silicon (111) wafers with a electrical resistivity between 10^{-1} and 10^{-2} ohm-meters were used as substrates. The electrical resistivity of the study whisker crystals was measured by the two-probe method after current leads were welded to them, and the type of conduction was determined by the thermoprobe method. The studies performed established that as the diameter of the whisker crystals decreases from 70 to 20 μm and as the growing temperature increases from 1,320 to 1,420 K, the crystals' electrical resistance decreases. This decrease is linked to an increase in the amount of initiating dopant captured during the growth process in accordance with the effective distribution coefficient. Figures 2, table 1; references 8: 7 Russian, 1 Western.

The Effect of Hydrogen on Selected Physical Properties of Doped Silicon Monocrystals

927M0058D Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 7, Jul 91 (manuscript received 24 Nov 89) pp 1345-1348

[Article by M.Ya. Dashevskiy, D.N. Korlyakov, G.D. Kuznetsov, and V.V. Perfilyev, Moscow Steel and Alloys Institute; UDC 546.28]

[Abstract] The authors of the study reported herein examined the effect that treatment in hydrogen high-frequency glow-discharge plasma has on the physical properties of monocrystalline silicon. n-Type phosphorus-doped silicon monocrystals and p-type boron-doped silicon monocrystals were grown in accordance with the Czochralski method and then subjected to treatment in hydrogen high-frequency glow-discharge plasma at temperatures ranging from 300 to 600 K with a discharge power density of 5 W/cm^2 and frequency of 13.56 MHz. The residual gas pressure amounted to 10^{-3} Pa, and the hydrogen pressure ranged from 5 to 100 Pa. The resultant wafers ranged in thickness from 400 to 1,500 μm . Silicon specimens that had first undergone heat treatment in a vacuum at 720 K for 150 hours to create heat donors in them were also subjected to the hydrogen plasma treatment. Tests performed on the study specimens revealed that p-type silicon monocrystals subjected to hydrogen high-frequency glow-discharge plasma treatment manifest an increase in the mobility and a reduction in the concentration of their basic charge carriers. The infrared absorption spectra of the treated specimens were also found to contain new absorption bands in the wave number intervals of 1,400 to 1,900 and 3,600 to 2,800 cm^{-1} . These bands were interpreted as confirmation of the formation of optically active hydrogen

complexes in the treated monocrystals. Figures 3, tables 2; references 5: 1 Russian, 4 Western.

The Magnetic Susceptibility and Selected Characteristic Features of the Chemical Bond in Alloys of the System ZnP_2 - $CdAs_2$

927M0058E Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 7, Jul 91 (manuscript received 8 Jan 90) pp 1353-1356

[Article by Ts.Z. Vitkina and V.M. Trukhan; UDC 621.315.592]

[Abstract] The authors of the study reported herein examined the magnetic susceptibility and selected characteristic features of chemical bonding in alloys of the system ZnP_2 - $CdAs_2$. The study alloys were produced from presynthesized compounds in the respective stoichiometric concentrations by protracted sintering in a vertical two-temperature oven. The composition of the alloys was controlled by x-ray phase and microstructural analysis. Their magnetic susceptibility was measured by the Gouy method in a vacuum of 10^{-3} Pa in various magnetic fields up to 10^6 A/m at 170 to 570 K. The Gouy weights had a sensitivity of 10^{-9} cm³/g. Before the magnetic susceptibility measurements were taken, the study specimens were treated (etched) and degassed in a vacuum (10^{-3} Pa) at 400 K for 4 to 5 hours. To clarify the mechanism of chemical bonding in the study alloys, the magnetic susceptibility was separated into Langevin diamagnetic and Van Vleck paramagnetic components. The dependence of the diamagnetic component of the magnetic susceptibility of the valence electrons on the covalence in the Zn-Zn, Zn-P, and P-P bonds in the compound β - ZnP_2 and in the Cd-As and As-As bonds in $CdAs_2$ were plotted. The change in the degree of covalence was found to have a comparatively weak effect on the magnitude of susceptibility in the metalloid-metalloid bond and to be somewhat stronger in the metal-metalloid bond. Analysis of the dependence revealed that the closer the covalence parameter to 1, the smaller the change in the diamagnetic component of the valence electrons for the different covalence parameters. This led the researchers to conclude that it is the Van Vleck paramagnetic component of magnetic susceptibility that reflects the principal change in the nature of bonding in a solid solution. The studies performed thus confirmed the formation of limited solid solutions based on ZnP_2 with a monoclinic structure and based on $CdAs_2$ with a tetragonal structure. The said process includes the breaking of the phosphorus (arsenic) chains and the appearance of P-As bonds. Figures 2; references 10: 7 Russian, 3 Western.

The Systems Er (Tm, Yb, Lu)-Ni-C and The Crystallization of Diamonds at Pressures Above 5.7 GPa

927M0058F Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 7, Jul 91 (manuscript received 17 Nov 89) pp 1544-1545

[Article by A.A. Putyatin; UDC 541.123.3:666.233]

[Abstract] This concise report discusses a study of (1) the phase diagrams of compounds of the ternary system Er (Tm, Yb, Lu)-Ni-C at pressures of 0.1 MPa and 4.6 GPa and a temperature of 1,100 K and (2) the crystallization of diamonds at temperatures of 1,700 to 1,800 K under a pressure of 6 GPa. Rare earth metals with a purity of at least 99.8% (by mass), electrolyte (purity, 99.99% [mass]) and carbonyl nickel, and ultrapure MG graphite (ash content, 0.03% by mass) were used as starting materials. The mixture of materials was annealed at 1,100 K in twice-evacuated and purified argon-filled quartz ampules with a titanium getter between the ampules. The study specimens were subjected to x-ray phase, differential thermal, metallographic, and microprobe analysis. In the concentration range studied, the phase diagrams of all four rare earth metal elements studied turned out to be the same and to contain the ternary compounds $RNiC_2$, $R_{11}Ni_{60}C_6$, $R_2Ni_{22}C_3$, and $R_4Ni_{13}C_4$. The $R_4Ni_{13}C_4$ carbides, three of which were synthesized for the first time, were found to belong to the structural type $Er_4Ni_{13}C_4$ (limiting boundary, Cmmm). The phase diagrams obtained at 6 GPa and 1,100 K were characterized by the existence of nickel carbon, and the free carbon was in the form of diamond. Spontaneous crystallization of diamond was found to occur between 1,700 and 1,800 K, and the temperature of the polymorphous transformation of carbon was found to be independent of the phase composition of the initial charge used. The process of the occurrence and growth of a diamond phase was found to occur in the presence of $xRNiC_2 + yR_2Ni_{22}C_3$ carbides or a melt thereof. Figure 1; references 11: 7 Russian, 4 Western.

²⁷Al NMR Spectra in Aluminozirconium Fibers

927M0058G Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA NEORGANICHESKIYE MATERIALY in Russian Vol 27 No 7, Jul 91 (manuscript received 9 Nov 89) pp 1550-1551

[Article by P.S. Kalinin, D.B. Dorzhiyev, V.N. Zuyeva, and V.Ye. Khazanov, Institute of Low-Temperature Physics Technology, Ukraine Academy of Sciences; UDC 546.621]

[Abstract] The authors of this concise report examined the ²⁷Al NMR spectra of aluminozirconium fibers with a high content of aluminum oxide and of massive specimens with an analogous chemical composition that had been annealed at temperatures between 900 and 1,400°C. The ²⁷Al NMR spectra were measured by an autodyne NMR spectrometer at a resonance frequency of 12,240 kHz. The ²⁷Al NMR spectra of the fibers annealed at temperatures between 900 and 1,150°C were found to consist of one line corresponding to the two-way transition from -1/2 to +1/2. The ²⁷Al NMR spectra of fibers annealed at temperatures between 1,200 and 1,290°C were found to contain three lines. The intensity of the satellite lines corresponding to two-way transitions from +/-3/2 to +/-1/2 was observed to be low. The ²⁷Al NMR spectra of fibers annealed at temperatures from 1,300 to 1,400°C were found to consist of five lines. The ²⁷Al NMR spectra in aluminozirconium fibers, as measured in this study, were found to indicate the following: Only a γ - Al_2O_3 phase occurs for fiber

specimens annealed between 900 and 1,150°C. Fibers annealed at 1,200 to 1,290°C have both a γ -Al₂O₃ phase and an α -Al₂O₃ phase. The transition to the α -Al₂O₃ phase is completed in fiber specimens annealed at temperatures from 1,300 to 1,400°C. In the case of the massive aluminosilicon specimens, specimens annealed at temperatures between 800 and 1,100°C had only a γ -Al₂O₃ phase, those annealed at 1,100°C had both a γ -Al₂O₃ phase and an α -Al₂O₃ phase; the transition to the α -Al₂O₃ phase was completed in those massive specimens that were annealed at 1,150°C or above. Figure 1; references 6: 4 Russian, 2 Western.

Local Crystallization of Titanium-Containing Glasses Under the Effect of Laser Radiation

927M0062A Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 17 No 2, Mar-Apr 91 (manuscript received 2 Feb 90) pp 242-246

[Article by V.P. Volkov, P.A. Skiba, A.G. Sechko, and A.G. Nepokoychitskiy, Mogilev department, Physics Institute, Belorus Academy of Sciences; UDC 535.211:539.213]

[Abstract] The authors of the study reported herein examined the physicochemical processes occurring when titanium-containing glasses are subjected to local laser radiation. They studied a titanium-containing glass produced by using a CO₂ laser to render an ST-50 pyroceram plate amorphous. Radiation with a radiating power of 6.4 and 5.4 W was used. Roentgenograms of the glass after it had been irradiated repeatedly contained all of the same (albeit smaller) peaks present in roentgenograms of the starting pyroceram plus the peak at 3.505 angstroms that is characteristic of amorphous pyroceram. A peak with this same interplane distance was observed elsewhere in the roentgenogram of glass of the same composition as ST-50 but subjected to low-temperature heat treatment (heat treatment at 998 K for 4 hours and heat treatment at 1,173 K for 1 hour). The process of the pyroceram's crystallization began from the center of the irradiation spot (where the laser effect is strongest) and moved outward. The area crystallized thus depended on the shape and intensity of the beam. The studies performed confirmed that laser radiation may be used to make local alterations in the optical properties of titanium-containing glasses by changing the ratio of crystalline and amorphous phases contained in them. The dependences of the shape and dimensions of the crystallized regions of the said glasses on the conditions under which the beam was formed and on the irradiation time may be used for purposes of optical information recording and producing crystallized glass volumes with a complex geometry. Figures 4; references 6 (Russian).

The Effect of Rubidium and Cesium Fluorides on the Structure and Properties of Phosphate Glasses

927M0062B Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 17 No 2, Mar-Apr 91 (manuscript received 25 Sep 90) pp 282-285

[Article by I.B. Urusovskaya, Ye.V. Smirnova, and S.A. Smepanov; UDC 666.11.01]

[Abstract] The authors of the study reported herein examined the effect that rubidium and cesium fluoride additives have on the properties and structure of glasses of the system Al(PO₃)₃-NaF. The study glasses were synthesized in a laboratory oven with pyroceram heaters in platinum crucibles. The charge was prepared from a mixture calculated to produce 100 g glass and was poured in in two installments. Twenty-five minutes was allowed to elapse between the time when the first installment was poured in and the glass mass was mixed. Temperatures of 900 and 1,100°C were used. The glass mass was poured off into a mold and subjected to fine annealing. The vitrification range in the systems containing the rubidium or cesium fluoride additives was much broader than that in the initial Al(PO₃)₃-NaF system. The glasses produced were subjected to infrared spectroscopy studies. Replacing the NaF in Al(PO₃)₃-NaF glasses by CsF had little effect on the glass's refractivity. Substituting RbF for NaF, on the other hand, did result in a decrease in refractivity. Making the said substitutions resulted in a linear increase in the density of the glasses. This increase in density was higher when CsF was used than when RbF was used. The glasses containing the CsF and RbF substituents turned out to be highly volatile. The main volatile components were phosphorus oxyfluoride and pentafluoride. According to the IR reflection spectra, the main structural units in the new glasses were pyrophosphate groups and (-P-O-P-) chains. Increasing the glassmaking temperature resulted in a reduction in the number of fluorophosphate groups and a simultaneous increase in the number of pyrophosphate groups. Increasing the content of CsF or RbF in the glass resulted in an increase in the concentration of pyro groups due to chain groupings. Figures 3, table 1; references 5: 4 Russian, 1 Western.

The Effect of Diffusion Stresses on the Properties of Ion Exchange Layers of Alkali Zirconium Silicate Glasses

927M0062C Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 17 No 2, Mar-Apr 91 (manuscript received 28 May 90) pp 293-298

[Article by L.B. Glebov, S.N. Derzhavin, S.K. Yevstropiev, N.V. Nikonorov, G.T. Petrovskiy, and O.S. Shchavelev; UDC 535.323:539.219:666.112]

[Abstract] Alkali zirconium silicate glass is one of the most promising materials for use in integrated optics. The authors of the study reported herein examined the mechanisms of the formation of the optical properties of alkali zirconium silicate glasses formed by the low-temperature exchange of Na⁺_{glass} and K⁺_{melt} ions. Zirconium silicate glass containing 15 mol% Na₂O and 15 mol% ZrO₂ was used as the study object. The ion exchange was conducted by immersing polished specimens into a KNO₃ melt at temperatures ranging from 350 to 600°C. The method of waveguide spectroscopy (wavelength, 0.63 μ m) with a wedge radiation input system was used to determine the optical characteristics of the ion exchange layers. An optical-polarization method described elsewhere was used to determine the magnitudes of the mechanical stresses and optical stress coefficient of the ion exchange layers.

The amount of change in the glass' volume during the ion exchange was measured based on the interference method, and a BAT-1 microhardness gauge was used to measure the glass specimens' microhardness. The studies performed revealed that as the ion exchange process unfolds, the increase in refractivity increases, reaching a maximum of 120×10^{-4} , which is a record for layers produced by low-temperature ion exchange. The zirconium silicate glasses examined were found to develop significant diffusion stresses during low-temperature ion exchange. These diffusion stresses in turn caused the microhardness of the study glasses to increase. The macroscopic stresses in diffusion layers of the study glasses reached about 3 GPa and gave the said layers a birefringence of about 6×10^{-3} . These stresses were determined to be responsible for about 60% of the total increase in the refractivity of the study glasses. The microscopic stresses in the glasses were found to cause a less-than-equilibrium amount of relative change in the volume of alkali zirconium silicate glass during ion exchange and were found to be responsible for an isotropic increase in the glasses' refractivity. Figures 3; references 16 (Russian).

The Effect of Extraneous Actions on the Optical Losses of Fiber Lightguides Made of Chalcogenide Glass

927M0062D Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 17 No 2, Mar-Apr 91 (manuscript received 1 Feb 89) pp 316-319

[Article by M.N. Vikhrov and Yu.V. Smirnova; UDC 661.7.068]

[Abstract] The authors of the study reported herein examined the effect that external effects have on the optical losses of fiber lightguides made of chalcogenide glass. Specifically, they measured photoinduced absorption in the range from 1 to 0.3 eV at temperatures of 77 and 300 K by using a fiber lightguide made of chalcogenide glass with the composition $As_{40}S_{45}Se_{15}$. The glass' forbidden band was approximately 2.1 eV wide. A fiber lightguide without any cladding and with a diameter of about 300 μm was used. The lightguide was about 1 m in length, and the irradiated segment was about 30 cm long. The DRSh-250 lamp (which has a distance of about 40 cm) and OS-11 filter used to produce the light radiation made it possible to isolate a region of the spectrum of 2.1-2.3 eV. At a temperature of 300 K there was a reversible change in the amount of transmission both for the region of absorption by type 1 centers (the region from 2.5 to 4 μm) and for the region of absorption by type 2 centers (the region from 1.6 to 2.5 μm). The magnitude of this effect was nearly identical for both types of centers. Specifically, the difference in the amount of photoinduced absorption by the two types of absorption centers did not exceed 20%. The relaxation of the photoinduced absorption of both types of absorption centers could be described by the dependence $\chi = \chi_0 \exp(-t/\tau)$. The time constant τ was very different for the different types of centers, however. It equaled 75 seconds for the type 2 centers and 166 seconds for the type 1 centers. Additional measurements (lasting 30 minutes each) revealed that the change in the amount of optical loss

of a fiber lightguide made of chalcogenide glass throughout the entire temperature range from 77 to 420 K does not exceed 1%. (which represents the bounds of the measurement error). The experimental data obtained demonstrated that the photoinduced absorption in the region of the spectrum investigated cannot be explained by a shift in the electron-absorption edge as has been proposed elsewhere. The type 2 absorption centers observed during the experiments reported herein are evidently analogous to absorption centers reported elsewhere. The type 1 centers, on the other hand, differ from those previously reported in chalcogenide glasses with respect to their temperature dependence and relaxation speed. Figures 2; references 10: 5 Russian, 5 Western.

The Effect of Temperature on the Radiation-Induced Optical Absorption of Lithium Lanthanum Phosphate Glass

927M0062E Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 17 No 2, Mar-Apr 91 (manuscript received 22 Jun 90) pp 320-323

[Article by G.N. Pirogova, A.I. Ryabov, V.Ye. Kritskaya, S.P. Naselskiy, M.N. Tolstoy, and Yu.K. Fedorov, Physical Chemistry Institute, USSR Academy of Sciences, Moscow; UDC 541.15:666.192]

[Abstract] The authors of the study reported herein examined the effect of temperature on the γ -radiation-induced optical absorption of phosphate glasses. For their studies, the authors used lithium lanthanum phosphate glasses synthesized under oxidation conditions, which are considered among the most promising glasses for use as the active elements of high-efficiency solid-state lasers. Glass specimens in the form of plane-parallel wafers about 1 mm thick were irradiated with ^{60}Co γ -rays at a dose of 3 Gy/s. After each irradiation cycle, the specimens' absorption spectra were recorded on a Specord M 40 spectrophotometer at room temperature. A U-12 linear accelerator was used to perform experiments on pulsed electron irradiation of specimens of the same glass. The experiments were conducted at an electron energy of 5 MeV, pulse duration of 2.3×10^{-6} seconds, and pulse current of 0.2 A. A high-speed spectrophotometer with a resolution of 1.8×10^{-7} seconds was used to record the optical absorption at the end of the electron pulse effect. The per-pulse absorbed dose amounted to 30 Gy. In nonirradiated glass optical absorption in the ultraviolet region is largely determined by iron ions (the most widespread and hard-to-remove process impurity). Under the effect of γ -irradiation at room temperature, on the other hand, optical absorption increases throughout the entire spectral region from 200 to 800 nm. More significantly, it also increases in the ultraviolet region. The spectra of the irradiated specimen contained absorption bands with maxima at wavelengths of 240, 410, and 510 nm. The bands' intensity increased monotonically as the irradiation dose increased. The increase in absorption in the ultraviolet portion of the spectrum was attributed primarily to a band of induced absorption whose maximum lay in the wavelength region below 200 nm. Increasing the irradiation temperature caused a lesser increase in optical density throughout the

entire spectral region from 200 to 800 nm, with the position of the maximum remaining virtually unchanged. The change in the radiation-induced absorption of lithium lanthanum phosphate glasses was observed to be analogous to that occurring in the case of postradiation annealing. The only (albeit slight) difference between postradiation annealing and heating during irradiation is seen when the annealing speeds of the radiation centers are compared: heating pre- γ -irradiated specimens reduces their optical density to a greater degree than does heating during irradiation. In the case of pulsed electron irradiation, there is a short-lived optical absorption with maxima at wavelengths of 230, 280, 410, and 510 nm. The temperature dependence of optical density is much less pronounced than in the case of stationary γ -irradiation, however. The dye centers occurring at each of the aforesaid wavelengths are discussed briefly. Figures 4; references 6: 5 Russian, 1 Western.

The State of Fe Ions in Xerogels and Glasses Produced by the Method of Sol-Gel Synthesis From Soluble Silicates

927M0062F Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 17 No 2, Mar-Apr 91 (manuscript received 6 Sep 90) pp 339-344

[Article by V.G. Dokuchayev, S.K. Yevstropyev, I.Kh. Isayev, G.T. Petrovskiy, Sh.K. Salimov, L.V. Khaldina, A.A. Eshbekov, D.M. Yudin, and V.S. Shashkin, State Optics Institute imeni S.I. Vavilov, Leningrad, and Samarkand State Pedagogical Institute imeni S. Ayni; UDC 666.11.01]

[Abstract] The authors of the study reported herein examined the coordination state of Fe^{3+} ions in quartz glasses produced by inorganic sol-gel synthesis. As study objects, the authors selected monolithic xerogels and glasses produced by inorganic sol-gel synthesis from soluble silicates (as described elsewhere) and then modified by iron ions. The iron ions were added by impregnating porous gels in FeCl_3 solutions. The predried xerogels were sintered in air at a temperature between 1,100 and 1,150°C. The study xerogels and glasses contained more than 99% (by mass) SiO_2 , 0.7% (by mass) Al_2O_3 , and less than 0.1% (by mass) $\text{NaO}_2 + \text{K}_2\text{O}$. The Fe_2O_3 concentration in the study glasses reached 0.6% (by mass). The state of the iron ions was studied by subjecting the glasses to optical and EPR spectroscopy. An SF-46 spectrophotometer in the range from 200 to 1,000 nm was used to measure the glasses' absorption spectra, and a Radiopan SELX radiospectrometer in the 3-cm range was used to measure the EPR spectra. To study the effect of γ -radiation on the state of the iron ions, the researchers subjected them to irradiation by a ^{60}Co source at doses up to 5×10^7 R. In the initial stages of heat treatment a significant portion of the iron ions were in a bivalent state, which was maintained when the xerogels were sintered into glass. Special emphasis was placed on investigating the irons in a trivalent state (i.e., the Fe^{3+} ions). Significant changes were found to occur in the Fe^{3+} ions when the xerogel was heat-treated and during the gel-glass transition. In the study glasses there was a long-wave shift of the absorption band of the Fe^{3+} ions as

compared with that in glasses produced by the conventional high-temperature methods. The EPR spectra of xerogels modified by iron ions contained three resonance signals characteristic for Fe^{3+} ions, namely, $g = 6.0$, 4.3 , and 2.0 . At the gel-glass transition point, there was a reduction in the fraction of Fe^{3+} ions in octahedral coordination ($g = 2.0$). The authors note that analogous results have been obtained for Fe^{3+} ion-modified gels produced by hydrolysis of metalloorganic compounds. γ -Irradiation of the test glasses was found to result in a partial reduction of the Fe^{3+} ions and in the formation of other radiation centers of a different nature. In the study glasses, Fe^{3+} ions were found to be the most active electron acceptors and the deepest electron traps. Figures 4; references 13: 9 Russian, 4 Western.

The Effect of a Magnetic Field on Formation of the Structure of Alkali Silicate Glasses

927M0062G Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 17 No 2, Mar-Apr 91 (manuscript received 24 Dec 88) pp 345-347

[Article by G.V. Zhmykhov, V.G. Pitsyuga, L.G. Pryadko, and V.I. Borulko, Donesk State University; UDC 66.11:538.6]

[Abstract] The authors of this concise report examined the effect of a magnetic field on formation of the structure of alkali silicate glasses. Specifically, they performed a series of spectral studies on alkali silicate glasses of the composition $0.37 \text{Na}_2\text{O} \cdot 0.63 \text{SiO}_2$ obtained by vitrification of a silicate melt in a constant magnetic field of up to 0.5 T. A UR-10 spectrometer was used to measure the study glasses' infrared absorption spectra, and an SKhR-200 spectrometer was used to record their ^{29}Si NMR spectra. The experiments performed revealed that in the study glasses, the intensity of the absorption bands in the region from 780 to 650 cm^{-1} depends (assuming identical vitrification process temperatures and times) on the intensity of the magnetic field. The infrared spectra of the study glasses were found to be a nonmonotonically dependent on the intensity of the magnetic field during vitrification, with the maximum change occurring at a magnetic field inductance close to 0.1 T. Analysis of the ^{29}Si NMR spectra recorded enabled the authors to conclude that during vitrification in a magnetic field, the ratio of the topological elements of a glass' structure changes. Specifically, the number of silicon-oxygen tetrahedra with a preponderance of nonbridge oxygen atoms increases, and the number of tetrahedra with bridge oxygen atoms decreases. On the basis of the results of the experiments reported and research published elsewhere, the authors conclude that a magnetic field may, by means of mechanisms of mixing singlet-triplet states of pairs of paramagnetic defects, change the likelihood of the recombination of complementary pairs of magnetic defects in the silicon-oxygen skeleton. This phenomenon is reflected in a change in the kinetics of structural relaxation during vitrification and, as a consequence, in a change in the degree of nonuniformity of the state and physical properties of the glass produced. Figures 2, table 1; references 15: 10 Russian, 5 Western.

Features of Bi(Pb)-Sr-Ca-Cu-O Superconductor Synthesis Through Precursors

927M0068C Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 pp 993-998

[Article by T. Ye. Oskina and Academician Yu. D. Tretyakov, Moscow State University imeni M. V. Lomonosov; UDC 541.4+537.312.62]

[Abstract] Discovery of bismuth superconducting cuprates with the general formula $\text{Bi}_2\text{Sr}_2\text{Ca}_{n-1}\text{Cu}_n\text{O}_{2n+4+\beta}$, where $n = 1, 2, \text{ or } 3$, has stimulated great interest in the preparation of homogeneous samples having reproducible properties, since the higher critical temperature homologs hold the most promise for practical applications. Normally, samples synthesized by direct mixing of oxides, carbonates, nitrates, oxalates, or their salts, do not have reproducible physical mechanical and structural properties, owing to dissimilarities at the micro level. This is due to local melting, competing reactions, reagent volatility, and the possibility of cationic substitution. As a result, the synthesis passes through the phase sequence 2201 - 2212 - 2223 (abbreviated by cationic index), the latter stage being very slow. Doping with lead enhances the speed of formation of homolog 2223, although the product still contains a mixture of phases. For this reason, direct synthesis has been replaced recently with multi-stage processes which permit a leveling out of those chemical properties of the initial reagents important for solid phase reactions. One possible variant, synthesis through a pre-calcined precursor, has been attempted and changes have been observed in the formation kinetics of phase composition and superconductor properties in comparison to direct mixing of reagents. The present work is a continuation of the precursor method and includes a new scheme for separating Bi(Pb)-Ca-Cu-O + Sr-Ca-Cu-O components, as well as a comparison with results obtained by direct methods. It was demonstrated that the precursor method allows the closest approach to preparation of samples consisting almost solely of homolog 2223 in the shortest time. Figures 3; references 6: 1 Russian, 5 Western.

Initiation of Chemical Reaction by High Frequency Impact in Powdered Titanium-Carbon Mixes

927M0068D Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 (manuscript received 24 Oct 91) pp 1009-1013

[Article by A. N. Gryadunov, A. S. Shteynberg, and Ye. A. Dobler, Structural Macrokinetics Institute, Chernogolovka, presented by Academician N. S. Yenikolopov, 17 Oct 91; UDC 541.11+534.16+539.74]

[Abstract] Reactions in heterogeneous condensed systems under high pressure deformation conditions take place over extremely short periods of time. This has been confirmed in experiments on static compression under shear deformation and in many experiments on shock-wave loading of powders. Characteristic reaction times have been estimated at 10^{-4} - 10^{-7} second. Until recently, comparison of reaction kinetics under shock-wave loading

with that of static conditions was possible only by extrapolation of low temperature kinetic data to high temperature regions characteristic for processes under impact-compressed condensed systems. This was due mainly to the lack of quantitative methods for recording the rates of high velocity reactions in condensed media at spatial-isothermal (static) conditions. In the present work the recently developed electro-thermal explosion method was used to study the macrokinetic characteristics of impact synthesis of titanium carbide from powdered titanium and carbon black to compare conversion rates under shock loading with that of static conditions. Experiments were conducted in a 14 mm duralumin ballistic device at a velocity of 1150-1300 meters per second. Time resolution comprised 50 nanoseconds. Reaction time under impact loading was over 5 orders faster than that of static loading. Figures 3; references 7: 5 Russian, 2 Western.

Tungsten Mineralization of Upper Archaic Supercrystalline Complexes of Keyvian Structure (Kola Penninsula)

927M0068H Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321, No 5, Aug 91 (manuscript received 2 Sep 91) pp 1058-1061

[Article by A. A. Basalayev and A. A. Kalinin, Geology Institute, Apatity, Presented by Academician D. V. Rundkvist, 16 Aug 91; UDC 553.463(470.21)]

[Abstract] The search for bedrock manifestations of scheelite mineralization in recent years has attracted the attention of researchers of the Kola Peninsula because alluvial aureoles have been detected in quaternary incrustations of the region over sizeable areas. High contents of tungsten were detected during the course of work conducted in the 1970's and 1980's in the archaic supercrystalline complexes of the northwestern, central, and eastern parts of the Kola Peninsula. Summarizing the published data led to the following conclusions: 1) scheelite mineralization is confined for the most part to the upper cut of the archaic amphibolitic complex, and is characterized by an elevated regional tungsten grade; 2) development of scheelite mineralization is related to metamorphic processes of various geochemical trends. These conclusions have been further confirmed in research on the tungsten content in the supercrystalline strata of the Keyv block, while other data indicate the presence of a morphogenetic type of mineralization of practical significance. Figures 2; references 3 (Russian).

Water Soluble Polyfunctional Polyelectrolytes Based on Styrene Copolymers

927M0072A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 14 May 91) pp 627-631

[Article by B. R. Tausarova, K. S. Taybagarova, Ye. Ye. Yergozhin, academician KazSSR Academy of Sciences T. D. Kozlovskaya, Kazakh State University imeni S. M. Kirov, Institute of Chemical Sciences, KazSSR Academy of Sciences, Alma-Ata; UDC 541.64+541.49]

[Abstract] Several novel nitrogen, carboxyl- and phosphorus containing polyelectrolytes were obtained with excellent sorption properties towards rare earth metal ions. Phosphorylation of styrene polymers with acrylic, metacrylic and maleic anhydrides was carried out in dimethylformamide and in presence of $AlCl_3$ using 5-20 moles of PCl_3 per mole of the copolymer. The degree of phosphorylation increased with elevation of the temperature and duration of the reaction. Products with maximum volume capacity of 7-8 mg-eq/g were obtained in presence of 15 moles PCl_3 and 1.5 mole $AlCl_3$ at 343 K in a reaction lasting 3 hrs. All of these polyelectrolytes adsorbed rare earth metal ions from aqueous solutions. The highest volume capacity was observed at pH 2-3. This capacity increased with the number of ligand groups in the macromolecule. The complex formation appeared to be a result of an ionic-coordination interaction of carboxyl and phosphate groups with the metal ions. Tables 2; Figures 4; references 7: 4 Russian (1 by Western authors), 3 Western (2 by Russian authors).

**Crystalline and Molecular Structure of
1,1-Bis(p-chlorophenyl)-1-hydroxy-
2-(phenylseleno)ethane With an Intramolecular
Hydrogen Bond O-H...Se**

927M0072F Moscow DOKLADY AKADEMII NAUK
SSSR in Russian Vol 319 No 3, Jul 91 (manuscript
received 16 May 91) pp 671-674

[Article by A. N. Chekhlov, S. I. Zavorin, S. A. Lermontov, academician N. S. Zefirov, Institute of Physiologically Active Substances, USSR Academy of Sciences, Chernogolovka, Moskovskaya Oblast; UDC 548.737:547.269.8:541.571.9]

[Abstract] Results of x-ray structural analysis of the crystals of 1,1-bis(p-chlorophenyl)-1-hydroxy-2-(phenylseleno)ethane were reported. This compound appears to be the only polysubstituted ethane with an intra-molecular hydrogen bond O-H...Se. The structure of the molecule, the values of the valence bond lengths and the valence and

torsion angles were tabulated. The paper then was devoted to a detailed description of the crystalline structure, the intra-molecular O-H...Se bond and molecular packing in the crystalline structure. Tables 3; figure 1; references 5: 1 Russian, 4 Western.

**Gold Containing Platinoid Tellurides and
Palladium Gold In Gabbro-Norites From Pansk
Range on Kola Peninsula**

927M0072I Moscow DOKLADY AKADEMII NAUK
SSSR in Russian Vol 319 No 3, Jul 91 (manuscript
received 20 May 91) pp 725-729

[Article by A. L. Krivenko, N. D. Tolstykh, N. N. Veselovskiy, O. N. Mayorova, Joint Institute of Geology, Geophysics and Mineralogy, USSR Academy of Sciences, Novosibirsk; Geological Institute of Kola Scientific Center imeni S. M. Kirov, USSR Academy of Sciences, Apatite of Murmansk Oblast; UDC 549.27]

[Abstract] Palladium gold (porpezite) was first identified some 200 years ago, but is a rare mineral. Palladium gold is a characteristic mineral along with Pt and Pd tellurides found in platinum rock territories in ranges of layered basic rocks. The composition and structure of Pansk range has been investigated in detail. Following platinoid minerals were identified in it: merenskite, moncheite, kotulskite, vysotskite, breggite, sperrilite, solid solutions of Pt-Fe-Cu and others. Among them the most commonly found are the tellurides of Pt and Pd. In moncheite and merenskite found in Vostochnyy Kievev strip, gold was discovered at the level of 1.6%. In the platinum bearing rock of this strip, an intermediate mineral between merenskite and kotulskite was found, a rather rare occurrence. In some of these minerals tellurium is replaced by bismuth, especially in the material from Zapadnyy Kievev. An assumption was expressed that the relationship between Te and Bi in these minerals could be used as a mineralogical thermometer. Tables 2; figures 4; references 12: 6 Russian, 6 Western.

Characteristics of Microphase Separation in Statistical Multiple Block Copolymers Containing Rigid and Flexible Blocks

927M0072E Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 13 May 91) pp 667-670

[Article by A. N. Ozerin, A. V. Rebrov, M. A. Krykin, A. M. Vasserman, I. P. Storozhuk, A. A. Dadali, correspondent member USSR Academy of Sciences N. F. Bakeyev, Scientific Physical-Chemical Research Institute imeni L. Ya. Karpov; Institute of Chemical Physics imeni N. N. Semenov, USSR Academy of Sciences, Moscow; Moscow Chemical-Technological Institute imeni D. I. Mendeleev; UDC 541.64:536.425:539.6:546.212:678-13]

[Abstract] Characteristics of the formation of microphases were studied on multiple blocks of polysulfate-polybutadiene block polymers; the aromatic oligo-sulfone blocks had the rigid structure and the oligo-butadiene blocks were flexible. 4,4'-Diphenylmethanediisocyanate

served as a chain extender; the content of flexible blocks ranged from 20 to 80 mass-% while the average molecular weight was maintained at about 5.5×10^4 . Analysis of experimental results seemed to indicate that with low content of the rigid phase in the block polymers, a segregation of rigid blocks occurred during the removal of the solvent and formation of each sample; this resulted in formation of poly-sulfone microphases with definite phase borders. This process is "forced" by highly reactive polar fragments of the chain extenders which compacts the rigid phase on one hand and leads to the formation of non-equilibrated conformations of flexible blocks on the other hand. This then leads to the appearance of excess free volume. Thus, an interesting possibility was discovered for modifying the structures of the flexible phase of block copolymers by introducing highly reactive molecular fragments between the blocks of the rigid and flexible phases and changing the selectivity of the solvent. Figures 3; references 6: 3 Russian (1 by Western authors), 3 Western.

Evolution of Powerful Ion Beam-Metal Surface System in Microsecond Interval

927M0059A Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 11 Sep 89, accepted for publication 18 Jul 90) pp 36-42

[Article by V. I. Boyko, V. P. Kishkin, I. V. Shamanin, Tomsk Polytechnical Institute; UDC 533.932]

[Abstract] Multicomponent composition, spectral and space-time characteristics of the beam interacting with the metal surface are responsible for the complex structure of plasma jet forming during the ionic current impulse. The behavior of plasma subsystem formed as a result of a 120 ns powerful proton-carbon ion beam bombardment of metallic targets was studied in a one μ s time interval on an earlier described model instrument. The ionic current density at the focus reached 1.6 kA/cm², with the energy of 660 keV. Its composition was: 60% protons and 40% carbon ions. The changes in thermal and hydrodynamic characteristics of the irradiated material were influenced by the ion beam parameters. It was established that spacial heterogeneity of the plasma parameters formed during the ion current impulse were preserved for a considerable period of time after its termination. Due to the different dragging abilities of the target material, the expanding plasma cloud separated into an external region with a higher temperature and faster mobility and a somewhat cooler and slower internal region. The characteristic time of the final redistribution of the ion beam energy liberated in the target by different dissipation channels was found to be 1 μ s, when the system reverted to the steady stage regimen. In the steady stage regimen, up to 70% of the reserve energy of the powerful ion beam was transformed into kinetic energy of the irradiated target, and 15% into the internal energy. About 15% of the energy supplied by the beam was removed by the gas and plasma forming at the irradiated surface. Figures 6; references 11: 8 Russian, 3 Western.

Exo-electronic Emission of Cd_xHg_{1-x}Te Crystals Irradiated with Fast Electrons

927M0059B Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 14 Dec 89, accepted for publication 29 Mar 90) pp 55-58

[Article by I. D. Burlakov, Yu. D. Dekhtyar, Yu. V. Matveyev, G. L. Sagalovich, A. I. Upmin'sh, A. V. Frolov, Riga Polytechnical Institute; UDC 537.533]

[Abstract] The goal of this study was to determine the pattern of the photo-thermally stimulated exo-electronic emission (PTEE) of the Cd_{0.2}Hg_{0.8}Te narrow band monocrystals irradiated with fast electrons. It was shown that room temperature irradiation of this material with high energy electrons resulted in an increased concentration of their donor centers. The PTEE of these monocrystals results from the annealing radiation defects of Hg_{Te}, Cd_{Te} and V_{Te} (apparently the Hg_{Te} defects dissociated at lower temperature than the Cd_{Te} defects). The spectra of PTEE show a characteristic single peak at 329 K and a gradual

decrease of the exo-emission current at 427 K. This peak reflects dissociation of the defect complexes corresponding to a first order reaction and an increase in the activation energy. The gradual decrease curve is related to the diffusion of tellurium vacancies towards the surface and reflects the presence of a "fast" and "slow" components of the diffusion of these defects. Figures 2; tables 2; references 16: 14 Russian, 2 Western.

Electrophysical Properties of Germanium Surface Modified by Millisecond Laser Irradiation

927M0059C Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 4 Dec 89, accepted for publication 23 Apr 90) pp 89-95

[Article by S. I. Kirrilova, M. D. Moin, V. Ye. Primachenko, O. V. Snitko (Deceased), I. N. Dubrov, V. A. Chernobay, Institute of Semiconductors, UkSSR Academy of Sciences, Kiev; UDC 621.315.592]

[Abstract] Electrophysical properties of the surface of germanium were investigated by the method of temperature dependence of the surface photo voltage after exposure to a neodymium laser beam at $\lambda=1.06$ nm millisecond impulses with varying energy of the light current, even exceeding the melting energy of the germanium surface. This made it possible to determine changes in the surface potential, its temperature-dependent characteristic and changes in the density of fast surface electron states (SES) with an increase of the energy of laser irradiation. It was shown that the concentration of SES increased smoothly with increasing energy up to the melting point of germanium. At the melting point ($E=30$ J/cm²) a rapid increase in SES concentration was observed. The absolute value of the surface potential expressed as a function of E goes through a minimum, probably due to the decrease of the density of slow SES resulting from the impulses of $E \leq 20$ J/cm². A temperature drop from 300 to 140 K resulted in an increased surface potential due to the electron charging of fast SES. At $T < 140$ K the surface potential expressed as a function of the temperature depends on the laser irradiation regimen (energy, number of impulses) and is related to the change of the structure and composition of the germanium oxide film during irradiation. Figures 9; references: 15 (Russian).

Data on Radiation Effectiveness and Contrast Characteristics in Electron and Ion Lithographs of Positive Polymer Resists

927M0059D Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 13 Aug 90, accepted for publication 5 Dec 90) pp 96-103

[Article by K. Kutova, G. Mladenov, Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Technological Center of Electronic Ray and Plasma Technologies and Engineering, Sofia; UDC 541.141.8]

[Abstract] Information of the time profiles in polymer resist materials is very important in the field of high resolution electron beam and ion beam lithography as are

the characteristics of the development processes: exposure as a function of the dose, depth developed in the resist material, etc. A method was developed for calculation of unknown parameters R_0 , B and A for an arbitrary couple of positive resist material-developer and for calculation of the radiation efficiency g in electronic and ionic lithographs. The method is based on the Monte Carlo method using the values of the stability rate as a function of the exposure dose. The characteristics of the developing process were calculated for specific cases. On the basis of these values it is possible to establish the form and the dimensions of the profiles in the resist materials expressed as a function of the exposure time and temperature. By proper selection of these parameters it is possible to obtain profiles with vertical and inclined walls. Excellent agreement was noted with data reported in literature. This method can also be used for negative resist-materials if the formula of the solution rate is available. Figures 5; Table 1; references 18: 2 Russian, 16 Western.

Formation and Annealing Characteristics of Dislocation Structures in Ion-Implanted Silicon Monocrystals During Rapid Thermal Treatment

927M0059E Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 18 Dec 89, accepted for publication 2 Feb 90) pp 113-118

[Article by G. A. Dovgyallo, F. F. Komarov, N. V. Sofronov, S. Yu. Shirayev, Scientific Research Institute of Applied Physical Problems, Belarus State University, Minsk; UDC 621.315.592]

[Abstract] Experimental results were discussed of the studies of the formation kinetics of delocalized structures during rapid thermal annealing (RTA) of Si monocrystals implanted with the III and V group ions. The principal task was the determination of the effect of the implanted admixtures under temperature-time varied conditions of RTA on the formation of dislocations and their removal from the crystals. A threshold temperature of 800-900° was identified: when this temperature was exceeded, the dislocation accumulation in the crystal-amorphous layer border was affected by their removal. The formation and growth of dislocation loops in the R_p zone takes place at the temperature which leads to a strong admixture deactivation. Formation of R_p dislocations is directly related to the breakdown of supersaturated solid solution. Implantation of donor admixtures in the silicon crystals leads to faster shifts of the dislocations in comparison to non-implanted material. A direct interrelation between translocation of implanted atoms and development of dislocalized structures was observed only in cases of insoluble admixtures of the III-group. Figures 6; references: 12: 1 Russian, 11 Western (2 by Russian authors).

Calculation of Diffusion in Formation Mechanism of Altered Layers of Multi Component Targets by Means of an Ionic Bombardment

927M0059F Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 23 Nov 89, accepted for publication 18 Jul 90) pp 125-130

[Article by I. I. Vosilyus, L. I. Pranyavichyus, Kaunas Polytechnical Institute; UDC 621.315.592]

[Abstract] The goal of this study was to determine the role of diffusion in the formation of an altered layer during ionic irradiation of multi-component targets. In this analysis an assumption was made that the pulverized atoms leave the solid body from the very top monolayer, and the diffusion itself represents the crossing of atoms between the neighboring monolayers. It was shown in this theoretical work that the elemental composition of the uppermost layer does not depend on diffusion-based mixing of the atoms. Thermal (radiation stimulated) diffusion alters the kinetics of the establishment of stationary distribution of the elemental composition in the layers without altering the elemental composition at the surface. This indicates that thermal diffusion may be excluded from the other physical processes initiated by ionic beams and leading to altered surface stoichiometry. Figures 3; references 6: 1 Russian, 5 Western (1 by Russian authors).

Ion-Beam Action of Silver on Nickel Structures

927M0059G Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 17 Oct 89, accepted for publication 29 Mar 90) pp 145-152

[Article by I. S. Tashlykov, Z. Al-Tamimi, Belorussian Technological Institute, Minsk; UDC 539.211:539.1.043]

[Abstract] In continuation of the earlier work, data were reported on reorganization of Ni structures implanted with Ag^+ ions, i.e. under conditions of the preservation of metallic bonds in the newly formed Ni-Ag entities. Using the method of transmission electron microscopy and Rutherford back-scattering of channeled ions, the internal reconstruction of the nickel structure ($\Phi_{Ag} > 10^{16} \text{ cm}^{-2}$) was established revealing silver inclusions in the irradiated crystals. It was established that the ion doses required for saturating a metal with defects of an implanted layer are about 2-3 orders of magnitude larger than those required for the semiconductors. Implantation of silver in nickel is not accompanied with formation of any non-metallic bonds but yet it stabilizes the radiation damage. Accumulation of Ag in Ni is associated with a probability of a polymorphic transformation. Figures 4; tables 2; references 35: 12 Russian (1 by Western authors), 23 Western.

Determination of Metal Thermal Conductivity Based on Pulse Photothermal Surface Deformation Kinetics

927M0059H Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 7, Jul 91 (manuscript received 16 Jul 90, accepted for publication 5 Dec 90) pp 155-157

[Article by S. V. Vintsents, Institute of Radiotechniques and Electronics, USSR Academy of Sciences, Moscow; UDC 661.8;536.2.023]

[Abstract] The method of photothermal surface deformation (PTSD) is one of the proven methods of photoacoustic and photometric diagnosis. A sample is heated with a laser beam leading to an appearance of PTSD at the radiation spot, - a result of an uneven spread of the heating effect. This

method has been studied adequately for the case of harmonic modulation of the heating light but not for the pulse modulation. In this paper results were reported of the study of the kinetics of pulsed PTSD within and out of the heating zone for a number of metal specimens: Ag, Cu, Mg, Al, Mo, In, Ni, Pb, Fe, Co, Sb, V and Bi. It was shown that this

method is applicable to determination of temperature conductivity χ under conditions of finite τ and a , by determining t_{\max} outside the impulse heating laser spot. This method was recommended for measurements of thermal diffusivity of complicated metal forms. Figures 2; references 5: 1 Russian, 4 Western.

Inadequacy of Heat Theory of Cavitation Processes

927M0072D Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 26 Feb 91) pp 656-659

[Article by M. A. Margulis, N. A. Maksymenko, All Union Scientific Research Institute of Organic Synthesis, Moscow; Moscow State University imeni M. V. Lomonosov; UDC 534.23:541.124]

[Abstract] The authors addressed the inadequacy of the old heat theory explaining the nature of primary elementary processes leading to the appearance of sono-chemical reactions and sono-luminescence in liquids, claiming that experimental factors can be produced supporting their own electric theory but contradicting the Noltingk-Neppiras heat theory. To provide the ultimate proof of the inadequacy of the heat theory, they proposed to analyze the principal aspects of the dynamics of cavitation bubbles and the results of the integration of differential equations describing their pulsation and collisions. A differential equation was derived starting from the Reyley-Pleset (names transliterated from Russian text) equation because of the difficulties encountered in numerical integration of the Noltingk-Neppiras equation. The van der Waal's equation was used to account for the non-ideal state of the vapor-gas mixture inside the cavitation bubble during its compression. The values of the maximum temperature obtained by solving this equation exceed the values obtained by other approaches. On the basis of these data a range of experimental conditions was plotted in three dimensional coordinates in which it was possible to register experimentally sono-luminescence. This cannot be explained by the heat theory. The only alternative theory

at present time is the new electric theory of cavitation processes proposed by the author. Figures 3, references 11: 7 Russian, 4 Western.

Electric Membrane Purification Technology for Industrial Solutions of Pentaerythritol From Sodium Salts

927M0072G Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 3, Jul 91 (manuscript received 1 Apr 91) pp 679-682

[Article by Academician of KazSSR Academy of Sciences Ye. Ye. Yergozhin, A. A. Tskhay, Z. A. Shishkina, U. T. Isenzhulova, Institute of Chemical Sciences, KazSSR Academy of Sciences, Alma-Ata; UDC 66.087.97:661.725.8]

[Abstract] Pentaerythritol is used in manufacturing pentaphtallic dyes and enamels. The presently used methods to purify PE result in excessive losses of the final product. In this paper results were reported of the investigation aimed at purifying industrial solutions of PE from the sodium salts. PE solution was desalinated in a multi-chamber electro dialyzer using ionic membranes. It was shown that a 5 hrs run over a pair of MA-40 and MK-40 membranes lowered the concentration of sodium formate from 59 to 5 g/l without changing the yield; however, as the degree of desalination increased, the electric resistance of the system increased resulting in larger energy expenditures. Electric conductivity and water permeability of various membranes was evaluated. A new electro dialyzer was designed in which the membrane gasket was fitted with a supply and draining tubing. This should have helped to block current overcharges, lower current leaks and increase the extent of useful surface of the ion exchange membrane. Table 1; figures 4; references: 7 Russian (3 by Western authors).

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