**NEW REUSABLE HIGH EFFICIENCY CATALYST OF HIGHLY CONCENTRATED HYDROGEN PEROXIDE DECOMPOSITION**

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***Keywords:*** *highly concentrated hydrogen peroxide, stabilizing, stainless steel, catalyst.*

The results of the development and properties study of high-performance reusable solid catalyst for decomposition of highly concentrated hydrogen peroxide without the use of noble metals with long-term stable performance and long service life are presented.

The total operating time of the catalyst package is more than 3,500 seconds, while no catalyst activity reduction and no traces of destruction have been found.

Experimental results have shown stable results of the main parameters in all test modes of the studies (reactor pressure, temperature, entrainment, etc.), which allows to conclude that there is no destruction of the catalyst and no loss of its properties. This confirms the prospects of using the developed catalyst as a reusable decomposition catalyst “ПВ-85” and “ПВ-98”.

Thorough elaboration of a technology and full-scale production of a new solid catalyst require broad-scale research and tests.

**References**

1. Schumb W.C., Satterfield C.N., Wentworth R.L. Hydrogen peroxide. Edit. by Gorbanev A.I., Doctor of Engineering. M: IL, 1958, 578 p.
2. Almazov O.A. Hydrogen peroxide oxidizers. Monograph. FGUP 25 GNIIMORF. [Moscow: FSUE The 25th State Scientific Research Institute of chemmotology of the Russian Ministry of Defense], М., 2004.
3. Patent GB 1399042, IPC B01J 23/72, 1972.
4. Patent US H1948H, IPC B01J 23/02, 2001.
5. Patent US 20040198594, IPC B01J 23/656, 2004.

**Background and current process solutions for initial separation stage of methylchlorosilane direct synthesis products**

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***Keywords****: methylchlorosilanes, methyl chloride, direct synthesis, synthesis off-gases, distillation, absorption.*

The historical succession and continuous development of methylchlorosilanes direct process by GNIIChTEOS researchers allow obtaining new technological solutions considering scientific and operating experience accumulated at GNIIChTEOS. The paper deals with a brief history of initial separation process of methylchlorosilane direct synthesis products. The latest achievements of GNIIChTEOS in respect of development and commercial implementation of the process allowing efficient separation of methylchlorosilane direct process products without additional power consumption are described in details. The new process provides stable production of raw methylchlorosilanes with lower content of methyl chloride, unreacted methyl chloride with low methylchlorosilanes content and process off-gases purification from methyl chloride. The technology is the result of the comprehensive approach to the considered process. While preparing the paper we used unpublished internal materials of GNIIChTEOS.

**References**

1.Rochow E.G. Silicon and Silicones. M.: Khimiya [Moscow: Publishing house **“**Khimiya”], 1990, 148 p. (in Russ.)

2. Khanashvili L.M. Chemistry and technology of organoelement monomers and polymers: Textbook for Universities. М.: Khimiya [Moscow: Publishing house **“C**himiya”],, 1998, 528 p. (in Russ.)

3. Molokanov Yu.K. et al The separation of mixtures of organosilicon compounds. L: Khimiya [Leningrad: Publishing house **“**Chimiya”], 1986, 336 p. (in Russ.)

4. B.Kanner, K.M.Lewis “Commercial production of silanes by direct synthesis” in “Catalyzed Direct Reaction of Silicon” by K.M.Lewis, D.G.Rethwisch. ELSEVIER, Amsterdam, 1993.

5. Endovin Y.P., Pererva O.V., Levchenko A.A., Chekrii Ye.N., Sokolov N.M., Polivanov A.N., Storozhenko P.A. Method for removing methyl chloride from gases. RU 2470697. Bull. no 36, 2012 (in Russ.)

6. URL: http://www.sustain-ed.org/pages/waste/dow\_mecl\_detail.html (date 07.05.2015)

7. Pererva O.V.**,** Endovin Yu.P., Chekrii Ye.N., Levchenko А.А., Storozhenko P.A. Polivanov A.N. Method of separation of mixture of methylchlorosilanes and methyl chloride. RU 2486191. Bull. no 18, 2013 (in Russ.).

**Organogermanium compounds. Synthesis, development and application prospects**

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***Keywords:*** *hydrogermylation, vinylsilanes, hydrogermanes, dielementethanes, silylolefins, dichlorogermylene.*

Methylchlorovinylsilanes hydrogermylation by methylchlorohydrogermanes and trichlorogermane etherate is studied. The effect of chlorine atoms and methyl groups number at silicon and germanium in the starting agents on the yield and composition of the obtained adducts is determined. The influence of silyl groups in starting silylolefin molecules on the investigated process is analyzed. The presence of the second silyl substituents is found to decrease the reactivity of silyl substituted ethylene in these reactions. On the contrary, at hydrogermylation by trichlorogermane etherate the presence of the second silyl group in an unsaturated compound molecule significantly increases the product yield. Reactions of halogen replacement to a germyl group in 1,2-dihalogenethanes by means of the latter interaction with available trichlorogermane complexes – dichlorogermylene etherate, aminate, phosphate and dioxanate were studied. It is found that dichlorogermylene dioxanate complex demonstrates the highest reactivity in these reactions. Quantum-chemical calculations of the studied reactions were performed.

**References**

1. Lukevits E.Ya., Gar T.K., Ignatovich L.M., Mironov V.F. Biologic activity of germanium compounds. Riga: “Zinatne”, 1980. (in Russ.)
2. Mironov V.F., Gar T.K. Organic compounds of germanium. M.: “Nauka” 1967. (in Russ.)
3. Mironov V.F. Investigations in the area of organogermanium compounds chemistry]. M.: NIITEKHIM [Moscow: Research institute for feasibility study in chemistry]. 1991. (in Russ.)
4. Gar T.K., Mironov. V.F. Biologic activity of germanium compounds. M.: NIITEKHIM [Moscow: Research institute for feasibility study in chemistry]. 1982. (in Russ.)
5. Shcherbinin V.V., Pavlov K.V., Komalenkova N.G., Chernychev E.A. Antimicrobial retention surgical suture. // Mezhdunarodnaya konferentsiya “Sovremennye tekhnologii vosstanovitel’noi meditsiny.[International Conference “Modern technologies of rehabilitation medicine”]. Sochi. May 12-16, 2001. pp. 376-377. (in Russ.)
6. Lakhtin V.G., Yakovleva M.V., Chernyshev E.A. The catalytic disproportionation of Organochlorosilanes and –germanes in the presence of Lewis acids. // Deposit article no. 2071-В2002. М.: VINITI [All-Russian Institute of Scientific and Technical Information of the [Russian Academy of Sciences](https://en.wikipedia.org/wiki/Russian_Academy_of_Sciences" \o "Russian Academy of Sciences)], 2002. (in Russ.)
7. Lakhtin V.G., Kurakaeva N.A., Mid’ko A.A. Pyatova Yu.I., Chernyshev E.A. Some regularities of silicon- and germaniumorganochlorides interaction with aluminum chloride. // Deposit article no1850-В2003. M.: VINITI [Moscow: All-Russian Institute of Scientific and Technical Information of the [Russian Academy of Sciences](https://en.wikipedia.org/wiki/Russian_Academy_of_Sciences" \o "Russian Academy of Sciences)]. 2003. (in Russ.)
8. Lakhtin V.G., Chernyshev E.A., Method of organochlorogermanes production. Patent RU №2260594, 2005 (in Russ.)
9. Chernyshev E.A., Komalenkova N.G., Bykovchenko V.G. New in the area of gas – phase synthesis of silicon, germanium and tin organochloroderivatives through dichlorosilylene reactions Izv. AN, Ser.khim. [Russian Chemical bulletin] 1998, no 6, pp. 460-465. (in Russ.)
10. Chernyshev E.A., Komalenkova N.G., Yakovleva G.N., Bykovchenko V.G. New organochlorogermanes gas-phase synthesis method through dichlorogermylene.Vestnik MITKhT [Fine Chemical Technologies], 2008, v. 3. no. 1, pp. 19-27. (in Russ.)
11. Chernyshev E.A., Komalenkova N.G., Yakovleva G.N., Bykovchenko V.G., Lakhtin V.G. Gas phase reaction of [dichlorogermylene with the chlorine-substituted ethylenes](http://elibrary.ru/item.asp?id=20445710) // Zh. Obshch. Khimii [Russian journal of general chemistry], 2013, v. 83, issue 2, pp. 225-229. (in Russ.)
12. Lakhtin V.G., Knyazev S.P., Pavlov K.V., Gusel’nykov L.E., Buravtseva E.N., Kuyantseva N.A., Parshkova L.A., Bykovchenko V.G., Kisin A.V., Chernyshev E.A. Hydrogermylation of silyl-substituted ethylenes with trimethylgermane and trichlorogermane etherate. //Zh. Obshch. Khimii [Russian journal of general chemistry], 2008, v.78, issue 5, pp.756-760. (in Russ.)
13. Lakhtin V.G., Volkova V.V., Gusel’nykov L.E. Parshkova L.A., Buravtseva E.N., Mokshanov A.N., Mid’ko A.A., Chernyshev E.A. Interaction of trichlorogermane ester complexes with vinylmethylchlorosilanes // Deposit article no 1730-В2005. М.: VINITI [Moscow: All-Russian Institute of Scientific and Technical Information of the [Russian Academy of Sciences](https://en.wikipedia.org/wiki/Russian_Academy_of_Sciences)]. 2005. (in Russ.)
14. Lakhtin V.G., Knyazev S.P., Pavlov K.V., Gusel’nykov L.E., Parshkova L.A., Buravtseva E.N., Kuyantseva N.A., Kirilin A.D., Chernyshev E.A. Synthesis of 1,2-bis(germyl)ethanes.// Deposit article no. 418-В2011. М.: VINITI [Moscow: All-Russian Institute of Scientific and Technical Information of the [Russian Academy of Sciences](https://en.wikipedia.org/wiki/Russian_Academy_of_Sciences)], 2011. (in Russ.)
15. Lakhtin V.G., Krylova I.V., Parshkova L.A., Ushakov N.V., Kirilin A.D., Chernyshev E.A. Hydrogermylation of vinylsilanes. //Deposit article no. 255-В2014. М.: VINITI [Moscow: All-Russian Institute of Scientific and Technical Information of the [Russian Academy of Sciences](https://en.wikipedia.org/wiki/Russian_Academy_of_Sciences)], 2014. (in Russ.)
16. Lakhtin V.G., Knyazev S.P., Volkova V.V., Gusel’nykov L.E. Parshkova L.A., Buravtseva E.N., Mokshanov A.N., Mid’ko A.A., Chernyshev E.A. Trichlorogermane etherate reactions with silyl substituents of ethylene. Conference “Organic chemistry from Butlerov and Bilstein to the present.” Tezisy dokladov [Book of abstracts, Saint-Petersburg.] 2006, no. 3-041, p. 523. (in Russ.)
17. Lakhtin V.G., Knyazev S.P., Parshkova L.A Quantum-chemical study of dichloro- and dibrommethanes reaction with dichlorogermylene. Simposium “Teoreticheskaya, sinteticheskaya, biologicheskaya i prikladnaya khimiya elemtntoorganocheskikh soedinenii” [Symposium “Theoretical, synthetic, biologic and applied chemistry of organoelement compounds” Saint-Petersburg]. 2011, p.67. (in Russ.)
18. Nefedov O.M., Kolesnikov S.P. Trichlorogermane etherates as sources of germanium chloride - germanium analogs of dichlorocarbene // Izv. AN SSSR. Ser. khim [Russian chemical bulletin], 1966, no. 2, pp. 201-211. (in Russ.)
19. Kolesnikov S.P., Perl’mutter B.L., Nefedov O.M. Interaction of germanium chloride dioxane complex with organic halide. // Dokl. AN SSSR [Proceedings of the [USSR Academy of Sciences](https://en.wikipedia.org/wiki/USSR_Academy_of_Sciences" \o "USSR Academy of Sciences)], 1971, v. 196, no. 3, pp. 594-596. (in Russ.)

**Chemistry and technology of organo-lead and organotin compounds in GNIIChTEOS**

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**Key words:** lead tetraethyl, antiknock agent for gasolines, organotin compounds, PVC stabilizers, catalysts, bioactive compounds, silylmethylstannanes, synthesis, technology, main researchers.

The author considers works of GNIIChTEOS researchers in chemistry and technology of tetraethyl lead (1930-1991) and organotin compounds (late 50s – up to present). Organomagnesium method in direct synthesis of organotin compounds and their processing technique are demonstrated, organogalogen stannanes in particular. The following issues are looked upon: efficient continuous organomagnesium method for tributylchlorostannanes synthesis; linear and cyclic silylmethylchlorostannanes process allowing the production of organotin compounds on their base with improved application characteristics. The names of principal investigators who made significant contribution to the research are listed.

**References**

1. Evans C.J., Karpel S. Organotin Compounds in Modern Technology // *J. Organometal. Chem. Library*, 1985, v. 16, pp. 1-279.
2. Shiryaev V.I., Mironov V.F. Divalent tin compounds – polycarbon analogs // Uspekhi khimii [[Russian Chemical Reviews](http://www.turpion.org/php/homes/pa.phtml?jrnid=rc)], 1983, v. 52, no 2, pp. 321-347. ( in Russ ).
3. Lukevits E.Ya., Mironov V.F., Gar T.K., Shiryaev V.I. et al. Synthesis, neurotropic and antitumor activity of a number of germatranes, germsesquioxanes and their organotin analogs. // Khim.-farm. Zh. [Pharmaceutical Chemistry Journal], 1984, v. 18, no 2. pp. 154-15 (in Russ).
4. Shiryaev V.I. Organotin compounds as insectoacaricides. // Agrokhimiya [Agricultural Chemistry], 2010, no 3, pp. 83-94. ( in Russ ).

**Basic advances in synthesis of ceramics forming organoelement oligomers**

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***Keywords:*** *oligomers, polycarbosilanes, nanometalcarbosilanes, organoalumoxanes, organoalumoxanesiloxanes, organotitaniumoxane alumoxanesiloxanes, organoyttriumoxanealumoxanes, organoyttriumoxanealumoxanesiloxanes, oxides, carbides.*

The paper deals with advances of SSC RF GNIIChTEOS in the area of competitive products synthesis – ceramics forming organoelement oligomers (polymers), that are representatives of high-tech chemical compounds and are indispensable for the development on their basis of new components for high-impact high-temperature and oxidation resistant nanoceramic composites, namely: ceramic fibers, matrixes, combined protective and barrier coatings, refractory powders. Researchers of SSC RF GNIIChTEOS have developed and patented high-performance synthesis methods of ceramics forming organoelement oligomers (polymers), - oligo(poly)carbosilanes and nanometalcarbosilanes – silicon carbide ceramic precursors, as well as elementoxane oligomers – organoalumoxanes, organoalumoxanesiloxanes, organotitaniumoxane siloxanes, organotitaniumoxane alumoxanesiloxanes, organoyttriumoxane alumoxanesiloxanes – precursors for high quality oxide ceramics of corundum, alumosilicate (mullite), alumotitaniumsilicate, alumoyttrium (garnet) and yttriumalumosilicate compositions.

**References**

1. Storozhenko P.A., Shcherbakova G.I. Advances in organoelement chemistry for the development of new materials. Mendeleev Commun., 2014, v. 24, pp. 133–137.
2. Shcherbakova G.I., Storozhenko P.A., Sidorov D.V., Shatunov V.V., Varfolomeev M.S., Yurkov G.Yu. Ceramic forming organoelement oligomers for advanced nanoceramic composite development. // Nanotekhnika [Nanoengineering], 2013, no. 3 (35), pp. 15–23. (in Russ)
3. Tsirlin A.M. The use of organoelement compounds for the production of advanced high-impact composite components. Khimicheskaya promyshlennost [Chemical Industry], 1995, no. 11, pp. 63(701)-67(705). (in Russ)
4. Tsirlin A.M., Fedorova T.V., Florina E.K. et al., Method of polycarbosilane production. Patent RU № 2108348, 1998. (in Russ)
5. Shcherbakova G.I., Zhigalov D.V., Sidorov D.V. Peculiarities of oxygen-free polycarbosilane process. ХIII Mezhdunarodnaya nauchno-tekhnicheskaya konferentsiya “Naukoemkie khimicheskie tekhnologii”[ХIII International conference “Science-intensive Chemical Technologies”], June 28 – July 2 Ivanovo- Suzdal: Book of abstracts , 2010, p. 381. (in Russ)
6. Storozhenko P.A., Shcherbakova G.I., Muzafarov A.M. et al. Ceramic forming carbosilanes: physicochemical properties, molecular structure peculiarities. Nanotekhnika [Nanoengineering], 2009, № 4 (20), pp. 7-13. (in Russ)
7. Storozhenko P.A., Tsirlin A.M., Gubin S.P., Guseinov Sh.L, Florina E.K., Shcherbakova G.I., Shemaev B.I., Izmailova E.A. New oxygen-free preceramic polymers – nanometal polycarbosilanes and nano-size fillers as unique materials to enhance strength and oxidation resistance of carbon-graphite and to stabilize high-strength high –temperature ceramics. // Membrany. Seriya Kriticheskie tekhnologii [Membranes. ser. Critical Technologies], 2005, № 4 (28), pp. 68-74. (in Russ)
8. Tsirlin A.M., Shcherbakova G.I., Florina E.K., Izmailova E.A., Shemaev B.I., Kirko M.V., Storozhenko P.A., Efimov N.K., Method of metalpolycarbosilanes production. Patent Ru № 2258715, 2005. (in Russ)
9. Shcherbakova G.I., Storozhenko P.A., Tsirlin A.M., Florina E.K., Yurkon G.Yu., Gubin S.P. Nanostructured ceramics based on nanozirconium polycarbosilanes in “Kosmicheskii vyzov XXI veka. Perspektivnye materialy i tekhnologii dlya raketno-kosmicheskoi nekhniki”.[ Space challenge of the XXI century. Promising materials and technologies for space-rocket engineering]. / Edited by Berlin А.А., Assorskii I.G., Мoscow.: Torus Press, 2007, v. 3, pp. 183-191. (in Russ)
10. Storozhenko P.A., Shcherbakova G.I., Tsirlin A.M., Florina E.K., Izmailova E.A., Savitskii A.A., Kuznetsova M.G., Kuznetsova T.M., Stolyarova I.V., Yurkov G.Yu., Gubin S.P. Synthesis of nanozirconium oligocarbosilanes. // Neorg. mater. RAN [Inorganic Materials, RAS], 2006, v. 42, no 10, pp. 1269-1277. (in Russ.)
11. Tsirlin A.M., Gerlivanov V.G., Popova N.A., Gubin S.P., Florina E.K, Shemaev B.I., Reutskaya E.B. Stabilization of Composite Ceramics Structures at High Temperatures via Nanopolymetallocarbosilanes // Proc. Of the 8-th Europ. Conf. on Composite Materials. ECCM-8, Symposium Ch.6. (3-6 June 1998, Naples – Italy), 1998, v.4, pp.137–144.
12. Gubin S.P., Tsirlin A.M., Popova N.A., Florina E.K, Moroz E.M. Clusters in a polymeric matrix. IV. Formation of Zr- or Ti- containing nano-particles in the process of oligocarbosilane transformation into polycarbosilanes, their structure and interaction with the matrix. Neorg. mater. RAN [Inorganic Materials, RAS], 2001, v. 37, no. 11, pp. 1317–1326. (in Russ.)
13. Tsirlin A.M., Shcherbakova G.I., Florina E.K., Popova N.A., Gubin S.P., Moroz E.M., Riedel R., Kroke E., Steen M. Nano-Structured Metal Containing Polymer Precursors for High Temperature Non-Oxide Ceramics and Ceramic Fibers – Syntheses, Pyrolyses and Properties // J. Europ. Ceram. Soc., 2002, v. 22, p. 2577–2585.
14. Shcherbakova G.I., Zhigalov D.V., Blokhina M.Kh., Sidorov D.V., Storozhenko P.A., Kuznetsova M.G., Chernyshev A.E., Drachev A.I., Yurkov G.Yu. Hafnium- and tantalum-containing carbosilanes: synthesis, physical-chemical properties. Simposium “Teoreticheskaya, sinteticheskaya, biologicheskaya i prikladnaya khimiya elementoorganicheskikh soedinenii”[“Theoretical, synthetic, biological and applied chemistry of organoelement compounds”, Symposium] December 05-07, 2011, Sanct-Petersburg: Book of abstracts, 2011, p. 72. (in Russ.)
15. Shcherbakova G.I., Blokhina M.Kh., Zhigalov D.V., Shatunov V.V. Nanometallocarbosilanes: synthesis, physicochemical properties, structure. // 9th International Workshop on Silicon-based Polymers ISPO-2013, September 22-25, 2013, Moscow: Book of abstracts. Moscow, 2013, p 83.
16. Shcherbakova G.I., Blokhina M.Kh., Storozhenko P.A., Zhigalov D.V., Sidorov D.G., Apukhtina T.L., Varfolomeev M.S., Sidorov D.V., Kuznetsova M.G., Yurkov G.Yu. Preceramic nanohafniumoligocarbosilanes. Neorg. mater. RAN [Inorganic Materials, RAS], 2014, v.50. no. 4, pp.457-464. (in Russ)
17. Shcherbakova G.I., Storozhenko P.A., Blokhina M.Kh., Shatunov V.V., Sidorov D.V., Sidorov D.G., Yurkov G.Yu. Nanometallocarbosilanes: synthesis, physicochemical properties, structure. // Journal of Chemistry and Chemical Engineering, USA, 2014, v 8, No.3, pp. 232-242.
18. Shcherbakova G.I., Storozhenko P.A., Sidorov D.V., Blokhina M.Kh., Kuznetsova M.G., Polyakova M.V., Chernyshev A.E., Yurkov G.Yu. Molecular structure peculiarities of preceramic nanozirconium oligocarbosilanes. Neorg. mater. RAN [Inorganic materials, RAS], 2011, v. 47, no 5, pp. 605-613. (in Russ.)
19. Blokhina M.Kh, Shcherbakova G.I., Storozhenko P.A., Zhigalov D.V., Sidorov D.V., Timofeev I.A., Timofeev P.A. Modifyers of carbon-carbon composites. // Komposity i nanostruktury [Composites and nanostrucrures], 2012, no. 4, pp. 2-13. (in Russ.)
20. Storozhenko P.A., Shcherbakova G.I., Tsirlin A.M., Florina E.K., Matskevich I.A., Chernyshev A.E., Murkina A.S., Varfolomeev M.S., Gubin S.P., Yurkov G.Yu. Organoaluminum and organosilicon compounds for advanced nanoceramic composites. Nanotekhnika [Nanoengineering], 2008, no. 2 (14), pp. 25–33. (in Russ)
21. Shcherbakova G.I., Tsirlin A.M., Storozhenko P.A., Efimov N.K., Florina E.K., Shemaev B.I., Murkina A.S., Method of polyalkoxyalumoxane production, silica-free binder on its basis.. Patent Ru № 2276155, 2006. (in Russ.)
22. Storozhenko P.A., Shcherbakova G.I., Tsirlin A.M., Murkina A.S. Varfolomeev M.S., Kuznetsova M.G., Polyakova M.V., Trokhachenkova O.P. Organoalkoxyalumoxanes and silica-free binder on their basis. Neorg. mater. RAN [inorganic materials, RAS], 2007, v. 43, no. 3, pp. 373–382. (in Russ.)
23. Storozhenko P.A., Shcherbakova G.I., Tsirlin A.M., Florina E.K., Rabinovich R.A., Murkina A.S. Varfolomeev M.S. High temperature oxidation resistant composite materials based on organoaluminum and organosilicon compounds // Perspektivnye materialy. M.: Interkontakt Nauka [Promising materials, Moscow: Publisher Intercontact Science Ltd**.]**, March, 2008, pp. 351–355. (in Russ.)
24. Varfolomeev M.S., Murkina A.S., Moiseev V.S., Shcherbakova G.I. Silica-free monoxide ceramic molds for critical castings of refractory alloys and high-melting metals. // Liteishchik Rossii [Russian Founder], 2009, no 9, pp. 35–37. (in Russ.0
25. Advanced Ceramics. US Industry Study with Forecasts for 2015& 2020, September 2011, (2794), 290 p.
26. [Krishan K. Chawla](http://www.google.com.ua/search?hl=ru&tbo=p&tbm=bks&q=inauthor:%22Krishan+K.+Chawla%22&source=gbs_metadata_r&cad=6), [Composite materials: science and engineering](http://books.google.com.sci-hub.org/books?hl=ru&lr=&id=rbuNxwzM27cC&oi=fnd&pg=PR5&dq=properties+of+oxide+ceramics&ots=UncLpvKjg5&sig=vZv1qkqaz9HJfS-vxMybS_CNaEg). Springer, 2012, 542 p.
27. Fergus J.W. [Oxide materials for high temperature thermoelectric energy conversion](http://www.sciencedirect.com.sci-hub.org/science/article/pii/S0955221911005036). // J. Eur. Ceram. Soc., 2012, [32(3](http://www.sciencedirect.com/science/journal/09552219/32/3)), pp. 525–540.
28. Suspension for ceramic molds fabrication by investment patterns. Korneev N.N., Shcherbakova G.I., Kolesov V.S., Chernyshev E.A. et al., Patent Ru № 1838986, 1996. (in Russ.)
29. Korneev N.N., Shcherbakova G.I., Kolesov V.S., Gerlivanov V.G. et al., Suspension for fireproof shell molds. Patent Ru № 1778944, 1997. (in Russ.)
30. Korneev N.N., Shcherbakova G.I., Antashev V.G., Yasinskii K.K., Gerlivanov V.G., Suspension for ceramic molds fabrication by investment casting. Patent Ru № 2082535, 1997. (in Russ.)
31. Korneev N.N., Shcherbakova G.I., Kolesov V.S. Manufacturing of Shell Moulds for Alumoxide Ceramics Molding. // Mechanical Behavior of Materials – VI. The Sixth International Conference Kyoto, Japan, July 29-August 2, 1991, ICM. 6, pp. 71–74.
32. Moiseev V.S., Varfolomeev M.S., Murkina A.S., Shcherbakova G.I. Quality improvement of gas turbine engine cast blades. // Liteishchik Rossii [Russian Founder], 2012, № 5, pp. 6–38. (in Russ.)
33. Murkina A.S., Shcherbakova G.I., Varfolomeev M.S. et al., Method for silica-free ceramic molds fabrication for precision investment casting of metals. Patent Ru № 2411104, 2011. (in Russ.)
34. Shcherbakova G.I., Storozhenko P.A., Murkina A.S., Varfolomeev M.S. et al., Method for ceramic mold fabrication for investment casting of metals. Patent Ru № 2412019, 2011(in Russ.)
35. Storozhenko P.A., Shcherbakova G.I. Synthesis of alumoxanesiloxanes and high-purity alumosilicates on their basis. // Neorg. mater. RAN (Inorganic Materials), 2011, v. 47, № 2, pp. 210–214. (in Russ.)
36. Shcherbakova G.I., Storozhenko P.A., Varfolomeev M.S., Sidorov D.V. Elementoxane oligomers as precursors for new generation of oxide ceramic materials. // Entsiklopediya inzhenera-khimika [Encyclopaedia of chemical engineer], 2013, no. 3, pp. 16–24. (in Russ.)
37. Shcherbakova G.I., Storozhenko P.A., Kutinova N.B., Varfolomeev M.S. et al., Method of yttrium containing organoalumoxanes production; binders and impregnating materials on their basis. / Patent Ru № 2451687, 2012. (in Russ.)
38. Shcherbakova G.I., Storozhenko P.A., Kutinova N.B., Sidorov D.V., Varfolomeev M.S. et al. Synthesis of yttrium containing organoalumoxanes. // Neorg. mater. RAN [Inorganic Materials, RAS], 2012, v. 48, № 10, pp. 1187–1192. (in Russ.)
39. Shcherbakova G.I., Krivtsova N.S., Kutinova N.B., Apukhtina T.L. et al. Fiber forming organoyttriumoxane alumoxanes. Favourable decision of 01.04.2015 to grant a patent Ru to application № 2014116827 of 25.04.2014. (in Russ.)
40. Shcherbakova G.I., Apukhtina T.L., Krivtsova N.S., Varfolomeev M.S., Sidorov D.V., Storozhenko P.A. Fiber forming organoyttriumoxane alumoxanes. // Neorg. mater.[Inorganic materials], 2015, v.51, №3, pp. 253-261. (in Russ.)
41. Shcherbakova G.I., Storozhenko P.A., Varfolomeev M.S. et al.; Method of yttrium containing organoalumoxane siloxanes production, binding and impregnation compositions on their basis. Patent Ru № 2453550, 2012. (in Russ.)
42. Shcherbakova G.I., Storozhenko P.A., Kutinova N.B., Krivtsova N.S., Varfolomeev M.S., Movchan T.L., Sidorov D.V., Kuznetsova M.G., Kuznetsova T.M., Yurkov G.Yu. Ashmarin A.A. Synthesis of organoyttriumoxane alumoxasiloxanes, production of glass and glass ceramics on their basis. // Neorg. mater. RAN [Inorganic materials, RAS], 2014, v.50, no 3, pp.331–338. (in Russ.)
43. Tkachenko L.A., Shaulov A.Yu., Berlin A.A. Heat-proof carbon materials. / Vse materialy. Entsiklopedicheskii spravochnik [All the materials Encyclopedic handbook], 2011, no 6, pp.31-38, № 7, pp. 10 – 15. (in Russ.)
44. Smeacetto F., Ferraris M., Salvo M. et al. Protective coatings for carbon bonded carbon fibre composites. // Ceramics International, 2008, v. 34, pp. 1297–1301.
45. Smeacetto F., Salvo M., Ferraris M. et al. Erosion protective coatings for low density, highly porous carbon/carbon composites. // Carbon, 2009, v. 47, № 6, pp. 1511–1519.
46. Sarkisov P.D., Popovich N.V., Orlova L.A. et al. Phase formation in Y2O3-Al2O3-SiO2 system and high temperature application of yttrium silicates. / Vse materialy. Entsiklopedicheskii spravochnik[All the materials, Encyclopedic handbook], 2011, № 6, pp.2-8. (in Russ.)
47. Shcherbakova G.I., Apukhtina T.L., Varfolomeev M.S., Sidorov D.V., Drachev A.I., Yurkov G.Yu. Glass-ceramic coatings baised on organoyttriumoxane alumoxanesiloxanes. // Neorg. mater. RAN [Inorganic materials, RAS], 2014, v.50, № 6, pp. 686–691. (in Russ.)
48. Shatunov V.V., Shcherbakova G.I., Blokhina M.Kh., Sidorov D.V., Varfolomeev M.S., Storozhenko P.A. Method of synthesis of nano-size refractory Zr, Hf, Ta metals through organoelement preceramic polymers. // [VII National conference on chemistry and nanomaterials of young scientists, PhD and students with the international participation "Mendeleev-2013"](http://mendeleev-spbu.org/index_en.php), April 2-5, 2013 г., St-Peterburg: Book of Abstracts, p. 204. (in Russ.)