PROPOSALS FOR COOPERATION

DEPARTMENT “TECHNOLOGY OF CERAMICS, REFRACTORIES, GLASS AND ENAMELS”

National Technical University
«Kharkiv Polytechnical Institute»

Department **“Technology of ceramics, refractories, glass and enamels”**
of National Technical University
«Kharkiv Polytechnical Institute»

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Department provide full-time training and learning:

- Bachelor (BA);
- Master’s (MA);
- Doctor of Philosophy (PhD)

by speciality “Chemical technology of refractory non-metal and silicate materials”

“Development of energy saving technologies of densely sintered ceramics for different functional purpose with the use of alternative raw materials”

Project manager: **Prof. Dr. OLENA FEDORENKO,**
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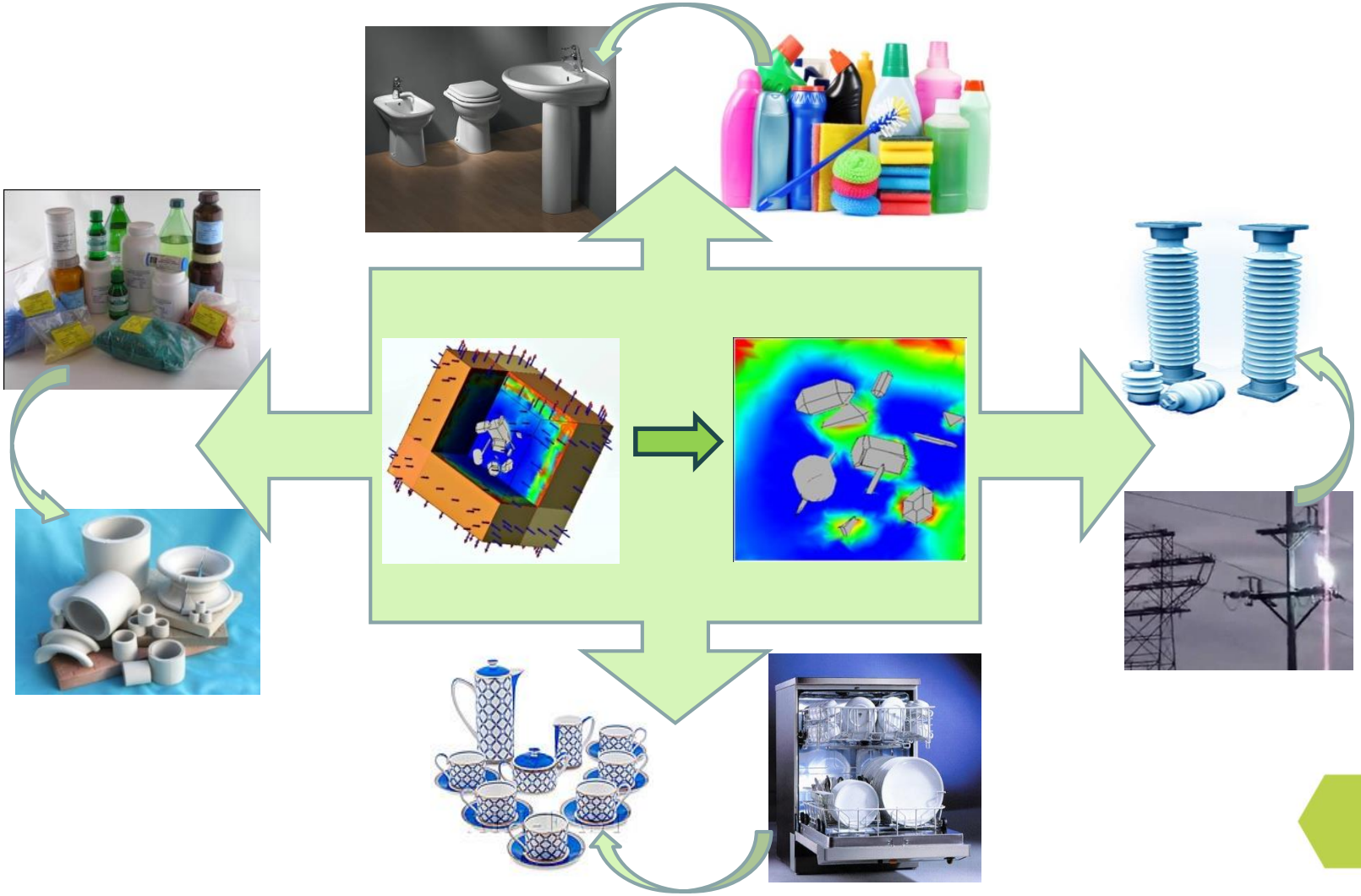
PROJECT GOAL

The development of energy-saving technologies densely sintered ceramics of different functional purpose on the basis of structural-phase modeling the behavior of materials under operating conditions



Brief project description

Depending on the application, ceramic articles were tested thermal, mechanical, electrical loads, and are exposed to aggressive environments. The effective life of the product is determined by the phase composition and structure of the material. Selecting the rational phase composition of ceramic based on the analysis of the stresses arising in the micro volume of material when exposed to loads which correspond to the real conditions of use of the products according to their functionality.

Methods of intensifying the process of sintering and phase formation based on the principles of chemical modification were determined, which ensure the formation of a densely sintered structure and phase composition for given ceramic materials at low-temperature firing by the introduction of complex additives, which regulate the rheological and crystallization properties by structural adjustment melt.

Low-temperature synthesis of densely sintered ceramic is based on the principle of directional structure- and phase- formation in accordance with the provisions of the basic physical-chemistry of silicates, as well as experience in the use of alternative raw materials (pyrophyllite, pegmatite, granite and granite siftings etc.) in the production of granite tiles, technical stoneware and porcelain of different functional purpose.

Expected results

- reduced production costs of natural gas (~ 25-30%) by reducing the temperature and duration reduction of the products firing;
- an exception depending on the raw materials export through the use of alternative mineral resources and development of technologies focused on raw material base of a particular region

PRELIMINARY ACHIEVEMENTS (properties of the developed materials)

Main properties	Granite tiles (gress)	House-hold porcelain	Insulators porcelain	Chemical resistant porcelain	Sanitary ware porcelain
Firing temperature, °C	1150	1150	1200	1200	1170
Water absorption, %	0,3	0,1	0	0	0,3
Heat resistance, the thermal cycles amount	-	8	-	10	8
TCLE·10^{-6}, 1/K	5,7	5,4	4,9	5,0	4,8
Translucence, %	-	34	-	-	
Compressive strength σ_c , MPa	-	-	126	-	115
Bending strength σ_b , MPa	30	56	76	62	59
Tensile strength σ_t, MPa	-	-	31	-	-
Whiteness WISO, %	-	65,15	-	-	
Acid resistance, mg/cm^2 (weight loss after boiling in 20,4 % HCl)	-	-	-	0,002	-
Dielectric strength $E_{str,}$ kW·mm^{-1} (f = 50 Hz)	-	34	-	-	-
Dielectric loss tg δ·10^3 (f = 50 Hz)	-	-	12,1	-	-
Volume resistivity ρ_V, Ohm·cm (t = 20 °C)	-	-	4,1·10^{14}	-	-
Chromaticity coordinates in L*A*B* system	-	L * = 80,3 a* = -2,67 в* = 10,47	-	-	-

INDUSTRIAL PROPERTY RIGHTS:

1. Patent of Ukraine № **38101**. Ceramic mass for obtaining white granite tiles. Ryschenko M.I., Fedorenko O.Yu., Firsov K.M., Shchukina L.P. Patentpending 17.06.2008. S04V 33/00. № u200808146. Issued. 25.12.2008. Bull. № 24. 4 p.

2. Patent of Ukraine № **46209**. Ceramic mass for obtaining low-temperature porcelain. Ryschenko M.I., Fedorenko O.Yu., Chirkina M.A., Firsov K.M., Zozulya S.A. Patentpending 26.06.2009. S04V 33/00. № u200906740. Issued. 10.12.2009. Bull. № 23. 2 p.

3. Patent of Ukraine № **73894**. Ceramic mass for making white granite tiles. Lisachuk G.V., Trusova Yu.D., Bilostotska L.O., Pavlova L.V., Fedorenko O.Yu., Zaikov V.V., Yuminov A.M. Patentpending 28.03.2012. S04V 33/00. № u201203768. Issued. 10.10.2012. Bull. № 19. 4 p.

4. Patent of Ukraine № **82849**. Ceramic mass for obtaining chemically resistant low-temperature porcelain. Ryschenko M.I., Fedorenko O.Yu., Trusova Yu.D., Bilostotska L.O., Pavlova L.V., Daineko K.B. Patentpending 25.02.2012. S04V 33/00. № u201302296. Issued. 08.12.2013. Bull. № 15. 4 p.

5. Patent of Ukraine № **8675**5. Ceramic mass for manufacture of porcelain products. Ryschenko M.I., Fedorenko O.Yu., Bilostotska L.O., Trusova Yu.D., Pavlova L.V., Ostrovna Yu.D. Patentpending 08.07.2013. S04V 33/24. № u201308557. Issued. 01.10.2014. Bull. № 1. 4 p.

6. Patent of Ukraine № **88999**. Ceramic mass for obtaining low-temperature electrical porcelain. Ryschenko M.I., Fedorenko O.Yu., Daineko K.B., Borisenko A.V. Patentpending 21.10.2013. S04V 33/26. № u201312269. Issued. 04.10.2014. Bull. № 7. 4 p.

7. Patent of Ukraine № **88996**. Non-frit glaze for porcelain products. Lisachuk G.V., Ryschenko M.I., Trusova Yu.D., Bilostotska L.O., Pavlova L.V., Hrenishena A.A. Patentpending 18.10.2013. S04V 41/86. № u201312233. Issued. 04.10.2014. Bull. № 7. 4 p.

8. Patent of Ukraine № **94033**. Matt non-frit glaze for porcelain. Lisachuk G.V., Ryschenko M.I.,

Trusova Yu.D., Bilostotska L.O., Pavlova L.V., Hrenishena A.A. Patentpending 15.05.2014.

S04V 41/86. № u201405146. Issued. 27.10.2014. Bull. № 20. 4 p.

Publications are devoted to process engineering aspects of manufacturing of densely sintered ceramics on the base of alternative raw materials

1. Possibility of obtaining ceramogranite using quartz-feldspar raw material from Ukraine / Ryschenko M.I., Shchukina L.P.,Fedorenko E.Yu., Firsov K.N. // Glass and Ceramics. – NY, 2008.– Volume 65.– Issue 1.– pp. 23–26.

2. Fedorenko E.Yu. The use of regional sources of raw materials in technology of low-temperature porcelain / O.Yu. Fedorenko, M.A. Chirkina, K.B. Daineko // Bulletin NTU "KPI". – Kharkiv, 2009. – Volume 24. – pp. 132–136.

3. Microstructure and properties of lower-temperature porcelain / Ryshchenko, M.I., Fedorenko, E.Yu.,Chirkina, M.A., Karyakina, É.L., Zozulya, S.A // Glass and Ceramics. – NY, 2009. – Volume 66.– Issue 11.– pp 393–396.

4. Fedorenko O.Yu. Electrotechnical porcelain with low-temperature firing based on new types of aluminum-silicate materials / O.Yu. Fedorenko, K. B. Daineko, A.V. Borisenko // Collection of scientific articles of PJSC "A.S. Berezhnoy Ukrainian Scientific Research Institute of Refractories". – Kharkiv, 2012. – Volume 112. – pp. 261-267.

5. Fedorenko O.Yu. Technological aspects getting densely sintered ceramics in terms of energy saving heat treatment / O.Yu. Fedorenko, M.A. Chyrkina, Yu.E. Shapovalova // Bulletin NTU "KPI". – Kharkiv, 2012. – Volume 68. – pp. 183–187.

6. Daineko E.B. Predicted probability of thermodynamic calculations of solid-phase reactions during the heat treatment of electroporcelain masses / E.B. Daineko // Bulletin NTU "KPI". – Kharkiv, 2013. – Volume 47. – pp. 38–44.

7. Fedorenko O.Yu. Methodology of flux component selection for ceramic masses according to positions of power saving / O.Yu. Fedorenko // // Bulletin NTU "KPI". – Kharkiv, 2013. – Volume 47. – pp. 169–177.

8. Energy-saving technology for household porcelain / Fedorenko, E.Y., Ryshchenko, M.I.,Daineko, E.B.,Chirkina, M.A. // Glass and Ceramics. – NY. – 2013.– Volume 70. – Volume 5.– pp. 219–222.

9. Daineko E.B. Pyrophyllite-containing Kuryanovsky and Ovruchsky rock deposits (Ukraine) as a raw material for the production of densely sintered ceramics / E.B. Daineko, A.M. Yuminov, A.G. Tokarev // Ore-capacity sedimentary and volcanic complexes. Metallogeny of ancient and modern oceans – 2013. – Miass, 2013. – Volume 19. – pp. 21–25.

10. Ways to intensify the processes of phases formation for masses and irrigation for sanitary porcelain / H.V. Lisachuk, L.O. Bilostotska, Yu.D. Trusova, L.V. Pavlova, Yu.D. Ostrovna, O.O. Hrenishena // Collection of scientific articles of PJSC "A.S. Berezhnoy Ukrainian Scientific Research Institute of Refractories". – Kharkiv, 2012. – Volume 113. – pp. 218-226.

11. Theoretical background of sintering ceramic materials intensification / M.I. Ryschenko, E.Yu. Fedorenko, E.B. Daineko, M.Yu. Lisyutkina // Refractories and technical ceramics. – Moscow, 2013. – Volume 11/12. – pp. 23–27.

12. To a question about the use of Ukraine pyrophyllite in the production of technical ceramics / E.B. Daineko, A.M. Yuminov, N.Yu. Gluschenko, O.A. Burik // Ore sedimentary and volcanic complexes. Metallogeny of ancient and modern oceans – 2014. – Miass: Yimin UrORAN, 2014. – Volume 20. – pp. 175–179.

13. The composition and properties of low-temperature electro-technical porcelain with Kuryanovskoy pyrophyllite / [E.B. Daineko, E.Yu. Fedorenko, N.Yu. Glushchenko and oth.] // Collection of scientific articles of PJSC "A.S. Berezhnoy Ukrainian Scientific Research Institute of Refractories". – Kharkiv, 2012. – Volume 113. – pp. 164-170.

14. Subsolidus conceptual design of CaO-Al_2O_3-TiO_2-SiO_2 system and its significance for manufacturing advanced ceramics / Ryschenko M.I., Pitak Y.N., Fedorenko E.Yu., Lisyutkina M.Yu., Shevtsov A.V. // China's Refractories. – 2016. – Vol.25. – Issue 1. – pp. 44–52.

15. Modern development prospects of raw material base electroporcelain / E.Yu. Fedorenko, E.B. Daineko, L.P. Shchukina, A.V. Borisenko // Věda a technologie: krok do budoucnosti – 2012. – Praha: Publishin house education and science SRO, 2012. – Díl 31: Chemie a chemická technologie. Zeměpis a geologie. – pp. 13–18.

• Previous studies contain priority results on development of the theoretical and technological bases of energy efficient technologies of densely sintered ceramic products for various functions using alternative quartz-feldspar and aluminosilicate raw materials under the auspices of Project Manager.

• Prof. Olena Fedorenko within the period 2006 to 2016 participated in development of technologies of granite tiles (gress) and low-temperature porcelain for house-hold, sanitary ware, chemical-technical and electrical purpose.

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“Development of the nanostructured ceramic materials with the increased physicomechanical properties and wear resistance”

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The list of the main publications and patents on a project subject
Scientific papers

1. Semchenko G.D., Gevorkyan E.S. Consolidated nanocomposite materials with the defined properties // Advances in Science and Technology, 2014.- Vol. 91. – Issue 3. - PP. 24-31.

2. .Semchenko G.D., Shuteeva I.Yu., Ryshcenko M.I. Formation of Material Prescraibed Phase Composition from Refractory Filler Silica Powder Modified with Alkoxide and Sol-Gel Composite // Refracrories and Industrial Ceramics, 2014. - Vol. 55. - Issue 3. – PP. 240-243.

3. Semchenko G.D., Povshuk V.V., Brazhnik D.A., Starolat E.E., Rozhko I.N. and Rudenko L.V. Creation of a combined ligvid phenolformaldehyde antioxidant-modifier for impoving periclase-carbon refractory life // Refractories and Inductrial Ceramics, 2016. -Vol. 56. - Issue 6.- PP.644-647.

4. Semchenko G.D., Panasenko M.A., Zelenskii O.I., Baklan V.Yu., Shuteeva I.Yu. Carbon precursors for synthesizing oxygen-free refractory new formations in carbon-graphite materials Refractories and Industrial Ceramics, 2010.- № .- P.

5. Semchenko G.D., Shuteeva, I.Yu.,, Slepchenko, O.N., Angolenko, L.A. Protection of graphite and graphite-containing materials from oxidation // Refractories and Industrial Ceramics , 2005. - Volume 46. - Issue 4. - PP. 260–267.

6. Dyakonenko N.L., Semchenko G.D., Starolat E.E. Electronic-microscopic research of filamentous crystals of silicon nitride // Surface, X-Ray, synchrotronnic, and neutron research, 2003.- Vol. 3.- PP. 92-95.

7.Semchenko G.D., Opryshko I. N., Angolenko L.A. Phase formation during hot pressing of modified silicon carbide powders and their mixtures with sintering aids. The structure and properties of materials // Refractories and technical ceramics, 2000. – Vol. 1. - PP. 16-26.

8.Semchenko G.D., Tischenko S.V., Opryshko I.N., Angolenko L.A. Thermodestruction of gel compositions based on ethyl silicate and boric acid.//Glass and Ceramics, 1999. - Vol. 1.- PP. 23-28.

9. Semchenko G.D., Starolat E.E. Technological aspects of ceramics production using sol-gel process // Ukrainian pottery. National annual for 1996-1999, 1999. – Vol. 4. - PP. 262-268.

10. .Semchenko G.D., Shuteeva I.Yu., Ryshcenko M.I Formation of Material Prescraibed Phase Composition from Refractory Filler Silica Powder Modified with Alkoxide and Sol-Gel Composite // Refractories and Industrial Ceramics, 2014. - Vol. 55.- Issue 3. - PP. 240-243.

11. Semchenko G.D., Makarenko V.V., Logvinkov S.M., Shuteeva I.Yu., Katyukha A.S. Features of high-strength composite material structure creation // Refractories and Industrial Ceramics, 2015. – Vol. 56. – Issue 2. – PP. 180-183.

12. Semchenko G.D., Povshuk V.V., Brazhnik D.A., Rozhko I.N, Starolat E.E., Vernigora K.P. Synthesis and Convertion Heating of Nickel-Containing Antioxidant Organic Precursor for Periclase-Carbon Refractories // Refractories and Inductrial Ceramics, 2016. - Vol. 57. – Issue 1. - PP. 33-37.

13. Semchenko G.D., Povshuk V.V., Brazhnik D.A., Starolat E.E., Rozhko I.N. and Rudenko L.V. Creation of a combined liquid phenolformaldehyde antioxidant-modifier for improving periclase-carbon refractory life // Refractories and Industrial Ceramics, 2016. – Vol. 56.- Issue 6. - PP. 644-647.

PURPOSE

Creation of composite materials with laminated structure and refractory materials with the nanostrengthened carbonaceous binders

Main objectives

- to create the matrixes of composite materials and the nanostrengthened carbonaceous binders of carboniferous refractory materials and carbon and graphite materials self-reinforced by nanoparticles;
- to develop technology of receiving of laminated materials of dual purpose;
- to increase physicomechanical properties, crack resistance and wear resistance, resistance to oxidation

Project essence

- application of mechanochemical synthesis of carbides nanoparticles of the set metals when modifying fillers of composite materials;
- creation of laminated structures in materials of dual purpose for increase of service characteristics;
- creation of new methods of hardening of carbonaceous binders in carboniferous refractories and carbon-graphite materials for ferrous metallurgy;
- application of nanotubes and sol-gel process during creation of technologies;
- application of new methods of consolidation of the composite materials allowing to reduce temperature of creation of poor-porous and pore-free composite materials at low sintering temperatures.

Scientific novelty and application

- mechanochemical synthesis of the set phases of nanoparticles when modifying fillers of materials;

- synthesis of nanoparticles β-SiC from components of sol-gel binding and pitch, phenolformaldehyde pitches, etc.;

- synthesis of nanotubes during sintering of materials with use of sol-gel compositions;

- creation of special structures of materials including laminated;

- increase in crack resistance and physicomechanical properties not only due to creation of nanostructures of matrixes of composite materials, but also by reinforcing of carbonaceous binders of graphite-containing materials and refractories.

Probable practical application

- new equipment;

- materials of dual purpose;

- ferrous metallurgy.

The expected result

- increase in crack resistance of composite materials by 2,5-4 times;

- increase in physicomechanical properties and resistance to oxidation of carboniferous materials for 35-45%.

Reviewed scientific monographs (21 – in total)

1. Gevorkyan E., Semchenko G. Modern composite materials. Material integrated processing technologies. - textbook - Saatbruken (Germany): LAP (Lambert Academic Publishing), 2016.- 376 p.(in Russian). ISBN 978-3-659-66196
2 Gevorkyan E.S. , Semchenko G.D., Timofeyeva L.A., Nerubatsky V.P. "New materials and methods of obtaining" . - book stamped by Ministry of Education of Ukraine.- Kharkiv .: "Disa +", 2015. - 344 p. - ISBN 978-617-7064-91-5 (in Russian).
3. Semchenko G. D. Sol-gel process in ceramic technology. - Kharkiv: BI., 1997. - 144 p. – ISBN 5-7763-8821-X
4. Semchenko G. D. Constructional ceramics and refractories. – Kharkiv: Shtrikh, 2000. - 304 p. - ISBN 066-593-119-9
5. Semchenko G. D., Povshuk V. V., Angolenko L.A., Borisenko O. N. Carbon-containing modified refractories. - Kharkiv: Oleynikova Yu. V., 2009. - 258 p. - ISBN 978-966-2209-00-6
6. Semchenko G.D, Shuteev I.Yu., Butenko A.N, Borisenko O.N, Starolat E.E / Sol-gel composition of multifunctional appointment. - Kharkiv: Helios, 2011. – 240 p. - ISBN 978-966-2209-16-7
7. Semchenko G. D., Borisenko O. N., Povshuk V. V. Nanostrengthened periclase-carbonaceous refractories. - Edition 2 corrected and added. - X.: Raduga, 2012. –128 p. - ISBN 978-966-2209-22-8

Industrial property rights (192 – in total)

1. Patent No. 56265 Ukraine, МПК C04B 38/08. Composition of charge material for production of Si_3N_4 Ceramics / Semchenko G. D., Starolat O. E; applicant and patent holder NTU "KPI".– No. u 201007044; submitted 07.06.10; published 10.01.11, Bulletin No. 1.
2. Patent No. 56263 Ukraine, МПК C04B 35/58, C04B 35/80. Method of growth technique for mix of β-SiC and α-Si_3N_4 nanofibres in ceramic matrixes / Semchenko G. D., Starolat O. E., Panasenko M. A., Dudnik Yu. P.; applicant and patent holder NTU "KPI". – No. u 201007024; submitted 07.06.10; published 10.01.11, Bulletin No. 1.
3. Patent for the invention No. 110253, Ukraine, МПК C04B 35/84(2006.01) C04B 35/65 (2006.01) C04B 41/87 (2006.01) Method of creation of corundum coatings / Semchenko G. D., Shuteeva I. Yu.; Rudenko L. V.; applicant and patent holder NTU "KPI". – No. a 2014 00273; submitted 10.12.2015; published 10.12.2015, bulletin No. 23
4. Patent No. 61961 Ukraine, МПК C04B 35/00. Composition for production of ceramic material / Semchenko G.D., Rozhko I. N., Vernigora K. P.; applicant and patent holder NTU "KPI"". – No. u 201041805; submitted 13.05.11; published 10.08.11, Bulletin No. 15.
5. Patent for useful model No. 91172 Ukraine, МПК C 04 B 35/65 (2006.01). Method of creation of an intermediate layer of corundum coatings / Semchenko G. D., Shuteeva I. Yu., Starolat O. E.; applicant and patent holder NTU "KPI". – No. u 2014 00274; submitted 13.01.2014; published 25.06.2014, Bulletin No. 12

“The special cements resource saving technology development and application for high temperature units maintenance under extreme operating conditions”

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PURPOSE

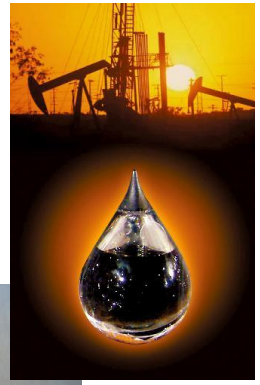
The special cements on the base of chemical production waste development and application for high temperature units lining of chemical, metallurgical and petrochemical industries performing under extreme conditions.

PROBLEMS

- Problem level analysis and the physical and chemical principles of special cements phase composition modeling development
- Phase formation processes and hydration products of special cements investigation
- Development of the composite materials based on high operating properties special cements
- Project results application

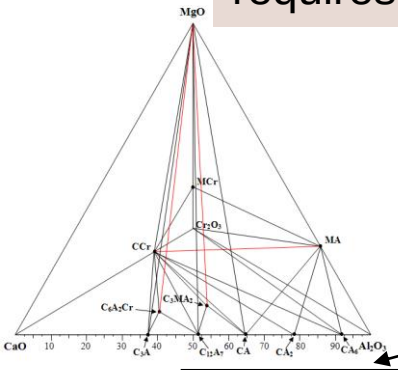
The expected result is the special cements new compositions with improved mechanical-strength and operating properties development






THE IDEA AND APPROACH

The chemical industry waste can be used as initial raw materials to special cements manufacture. The special cements phase composition choice accuracy requires the multicomponent oxide systems subsolidus structure studying



STRUCTURE OF THE RESEARCH

Purpose, objectives

Theoretical

The multicomponent oxide systems subsolidus structure investigation

The eutectics estimation

Geometric-topological analysis of systems

The special cements phase compositions areas optimization

Experimental

Analysis of the chemical and phase composition of the waste

Chemical and phase composition of clinker and special cements

Determination of physical and mechanical properties of special cements

Physico-chemical principles of special cements synthesis

Practical applications

Technological scheme of the special cements obtaining

Dry mixes for gunning masses and refractory concretes

PRELIMINARY ACHIEVEMENTS

The special refractory cement compositions based on chemical production waste of Ukraine have been developed by project team. The mechanical-strength properties of developed cement do not yield the best world analogues.

Comparative characteristics of refractory cements

Indicators	AC-40 (Ukraine)	Ciment Fondu Lafarge (France)	Alcoa CA-14M (USA)	Gorkal-40 (Czech)	Istra-40 (Germany)	Modified with the replacement of calcium raw materials (NTU «KhPI»)	Modified with the replacement of calcium and alumina raw materials (NTU «KhPI»)
Production method	Sintering	Sintering	Melting	Sintering	Melting	Sintering	Melting
Content Al_2O_3, mass. %	35-45	38-40	71-73	38-41	39-42	65-70	35-40
Specific surface, $м^2/kg$	> 3000	2850-3450	3550	3500	3000-3400	> 3500	> 3500
Setting time, hour-min, - start - end	2-00 5-00	5-30 4-00	4-40 5-50	1-10 2-10	3-00 4-00	0-30 1-30	1-00 2-00
Compressive strength, MPa	39-45	45-50	35-50	35-40	42-45	55-60	55-65
Refractoriness, °C	1350	1300	1550	1300	1300	1650	1550

PUBLICATIONS

Monografs

- Pushkareva, K.K., Dvorkin, L.J., Hradoboyev, O.V., Zaichenko, M.M. Kaganovskiy, O.S., Plugin, A.A., Tymoshenko, S.A. and Shabanova, G.N. (2014) Energy saving mineral binders and composite building materials based on them, Zadruga Publ. (in Ukrainian).
- Shabanova, G.N., Korohodska, A.N., Mirgorod, O.V., Deineka, V.V. and Tsapko, N.S. (2014) Calcium and barium oxide systems and binders based on their kompositions, Planeta-Print Publ (in Russian).
- Pushkareva, K.K., Bambura, A.M., Dvorkin, L.J., Gradoboev, O.V., Zotsenko, M.L., Kaganovskiy, O.S., Pavlikov, A.M., Plugin, A.A., Tymoshenko, S.A. and Shabanova, G.N. (2014) Modern building materials and structural systems for the construction of affordable housing and infrastructure, Zadruga Publ. (in Ukrainian).
- Shabanova, G.N., Pitak, Y.N., Taranenkova, V.V., Proskurnya, E.M., Mokritskaya, V.K., Korohodska, A.N. (2016) Refractory cements on the base of multicomponent zirconium systems compositions, Publ. Rozhco, S.G., (in Russian).

Conference presentations

- Shabanova, G.N., Kiseleva, S.A. and Shabanov, D.N. Intensification of Phase Formation in the $CaO\text{-}SiO_2\text{-}H_2O$ System. 18 International Baustofftagung, Weimar, Bundesrepublik, Deutschland, September, 2012.
- Shabanova, G.N. and Korohodska, A.N. Features of the hydration mechanism of alumina and chromite cements, 19 International Baustofftagung, Weimar, Bundesrepublik, Deutschland, September, 2015.
- Shabanova, G.N., Vorozhbiian, R.M. and Ryshchenko, T.D. Alumina cement on chemical industry wastes, 19 International Baustofftagung, Weimar, Bundesrepublik, Deutschland, September, 2015.

Peer-reviewed publications

Shabanova, G.N. and Korohodska, A.N. (2016) Alkali-earth Element Aluminates and Chromites Cement Bonded Refractory Castables. China's Refractories. 25 (1): 26-31.

Patents (in Ukrainian)

-Shabanova, G.N., Logvinkov, S.M., Shumeyko, V.N., Korohodska, A.N., Krivtsova, N.K. and Khrystych, O.V. Pat. Appl. **74792** Ukraine (2012).
-Shabanova, G.N., Korohodska, A.N., Vorozhbiian, R.M., Shumeyko, V.N. and Ryshchenko, T.D. Pat. Appl. **80406** Ukraine (2013).

“Advanced functional ceramic, glass-ceramic materials and ceramic coatings”

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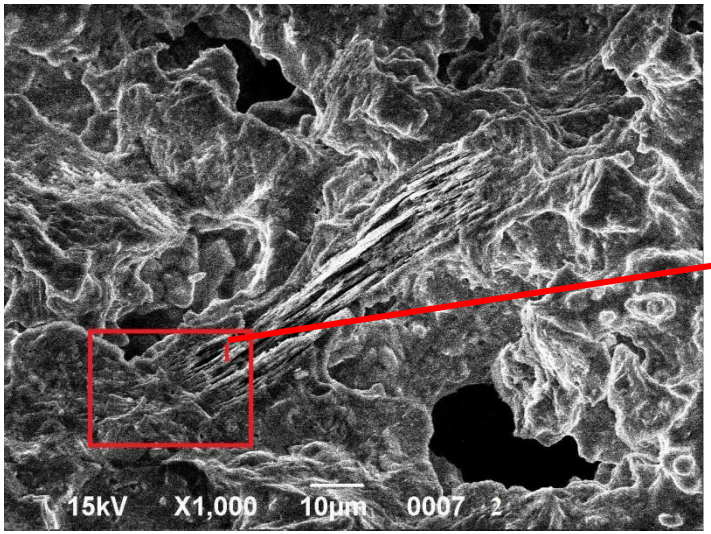
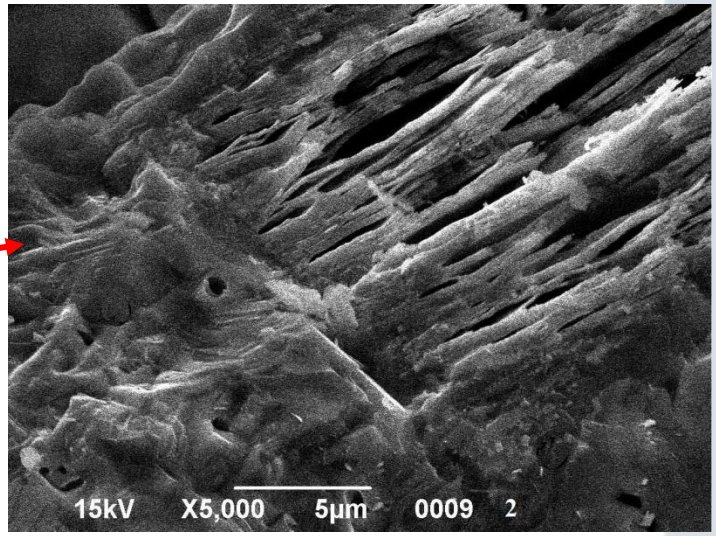
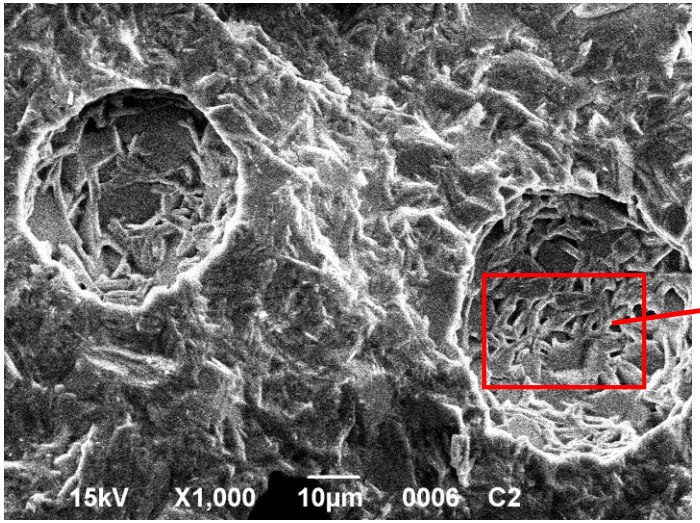
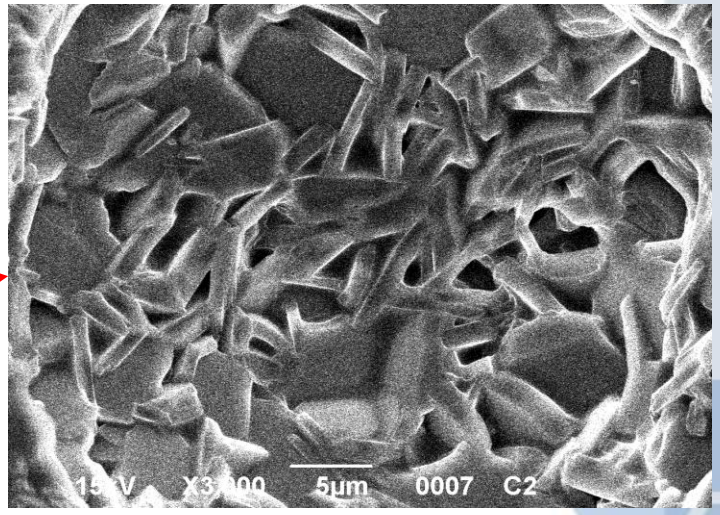
Physical and chemical bases of chemical-, thermal-, bio- and wear-resistant materials and coatings, including special purpose ones for ceramics, operating in severe and extreme conditions have been developed.









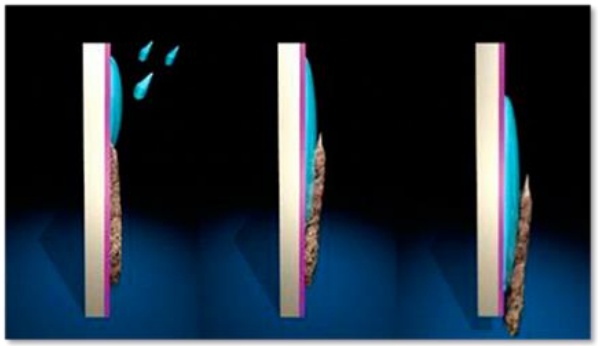
Self-reinforced composite materials and coatings obtained by directed crystallization of a given phase.

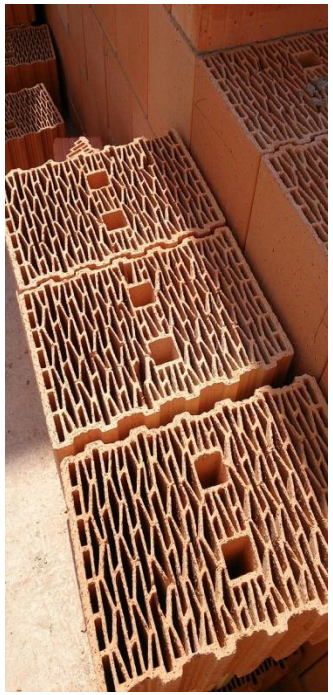
The main idea behind the development is to find evidence-based energy-saving synthesis conditions of ceramic and glass-ceramic materials exhibiting simultaneously a set of standard and special properties increasing their durability, extending fields of use and allowing to range them in a new class of highly resourceful materials.

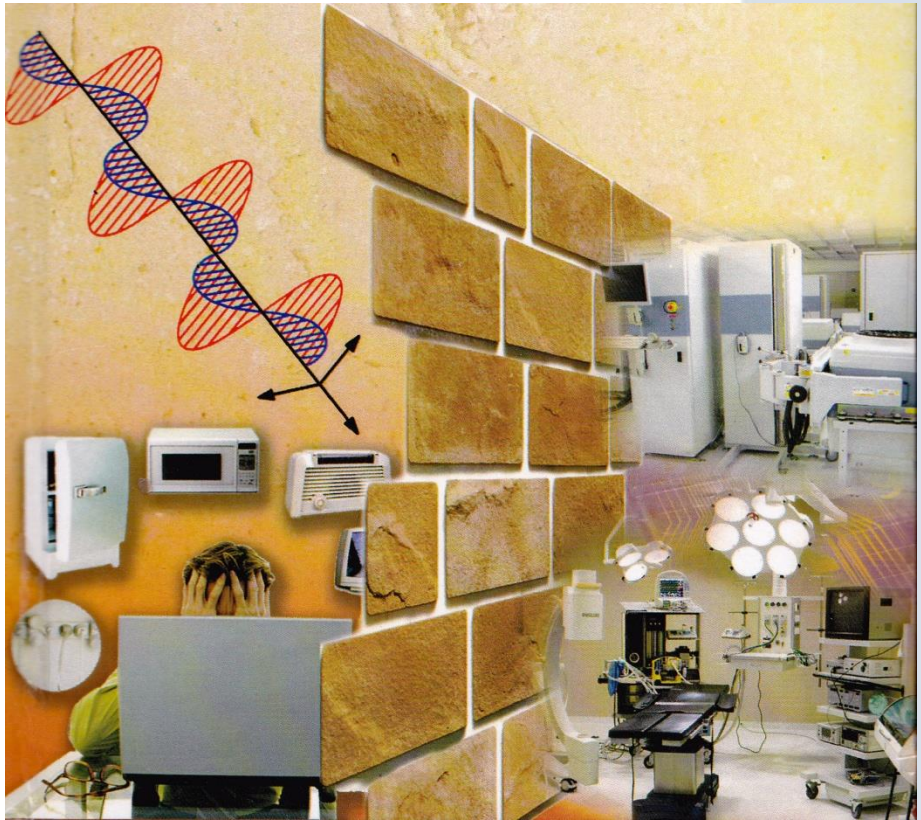
Directed synthesis of materials should be carried out under the influence of modifying compositions, affecting the activity of the liquid phase during sintering and determining technological conditions for obtaining materials with the given structure under conditions of low temperature synthesis.

Developed processing technologies of:

- technical ceramics with specific properties;
- facade ceramics with bioresistant non-biocidal coatings;
- energy efficient construction materials.







Selected publications

1. Thermodynamic analysis of solid phase reactions in SrO-AL_2O_3-SiO_2 system / G.V. Lisachuk, R.V. Krivobok, A.V. Zakharov, E.Yu. Fedorenko, M.S. Prytkina // Functional Materials, 2016. – Vol.23, Issue 1. – PP. 71-74.
2. Study of the subsolidus structure of the system ZnO-Al_2O_3-TiO_2-SiO_2 / Ya. Pitak, G. Lisachuk, K. Podchasova, Yu. Trusova, R. Krivobok // Eastern-European Journal of Enterprise Technologies, 2016. – Vol. 2/6 (80). – PP. 71-76.
3. Directed phase formation of functional glass-crystalline coatings for ceramics in $Ti0_2$-Al_2O_3-SiO_2 system / G.V. Lisachuk, L.O. Bilostotska, Yu.D. Trusova, K.P. Vernigora, K.V. Podchasova, R.V. Krivobok // Functional Materials, 2015. – Vol.22, Issue 4. – PP. 547-551.
4. Thermodynamics of reactions of crystalline phases formation in the three-component system SrO–Al_2O_3–SiO_2 / A.V. Zakharov, O.S Rybinin , M.S Prytkina, G.V. Lisachuk, R.V. Krivobok // Nanotechnology and nanomaterials (Nano-2015): International research and practice, 26-29 August 2015. – Lviv, 2015. – P. 24.
5. G.V. Lisachuk, Krivobok R.V., Zakharov A.V., Fedorenko E.Yu. Prospects for creation of ceramic rediotransparent materials // Abstract book Summer school and international research and practice conference: Nanotechnology and nanomaterials (NANO–2014). – 23–30 August 2014, Yaremche–Lviv. – 2014 – PP. 205-206.
6. Theornetcal background of alkaline-free tin content coatings on ceramics in the system RO-SnO_2-Al_2O_3-SiO_2 / G. Lisachuk, O. Fedorenko, O. Pitak, L. Bilostotska, Yu. Trusova, L. Pavlova, K. Dayneko // Chemistry and chemical technology. – L'viv, 2013. – Vol.7, No.3. – PP. 351-354.
7. G.V. Lisachuk, R.V. Krivobok, A.V. Zakharov Prospects for creation of ceramic radio absorbing aterials // Conference for young scientist in ceramics SM- 2013 (Novi Sad, Serbia, 06-09 November 2013): Fuculty of Technology Univerrsiry of Novi Sad, 2013. – PP. 64-65.

- Prof. **Georgiy V. Lisachuk** author and co-author of more than 250 papers, 3 monographs, 83 author's certificates and patents.
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We invite scientific and industrial organizations to cooperate with us in developing new functional ceramic, glass-ceramic materials and ceramic coatings!

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Please contact us and we will answer all your questions :)