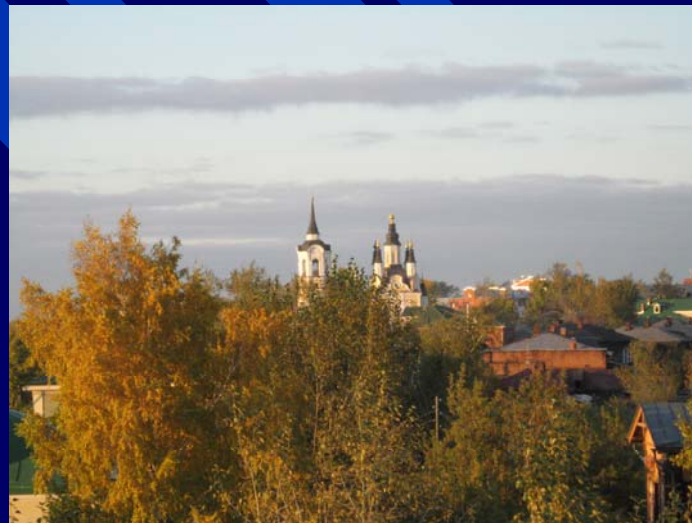


# Tomsk Polytechnic University

## Chemical Engineering Department



**Chair of Silicates Technology  
and Nanotechnology.  
105 Years of Development**

**Alexander Gromov, Ekaterina Kulinich**

**Tomsk Polytechnic University**

# Chair of Silicates Technology

## Head of the Department

**Vereshchagin Vladimir I.,**  
**Professor, D Tech Sc**  
**([vver@tpu.ru](mailto:vver@tpu.ru))**  
**tel/fax: +7 3822 563 169**

## Staff:

**6 Professors**  
**12 Associate**  
**professors,**  
**12 PhD students,**  
**4 Senior researches**

**Chair was founded in 1902 and**  
**approximately 5,500 engineers**  
**have educated since then**



# History of the Chair of Silicates Technology

- 1902 Chair of the Technology of Mineral Raw Materials
- 1929 Chair of Silicates Technology
- 1995 Dissertation Committee (PhD level)
- 2001 Dissertation Committee (Doctoral level)
- 2002 100-years anniversary

## Chairmen (since 1902)

- 1902-1909 Prof. Sabek E.A.
- 1909-1915 Prof. Yuferev V.F.
- 1918-1939 Prof. Ponomarev I.F.
- 1939-1941 Prof. Logvinenko A.T.
- 1941-1943 Prof. Staub K.I.
- 1943-1977 Prof. Usov P.G.
- 1977-1978 Ass. Prof. Dubovskaya N.S.
- 1978-1979 Ass. Prof. Lotov V.A.
- 1979-now Prof. Vereshchagin V.I.



- Room 117 (in 1912)
- Room 117 (in 2002)

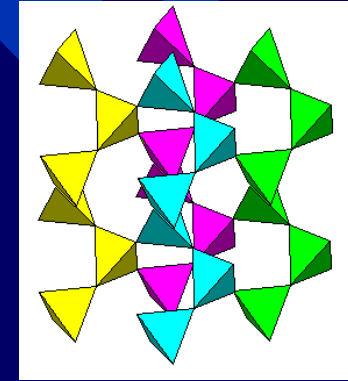


# Full Education Cycle (since 1995)

**B Sc program**



**M Sc program**



**Candidate of Technical Science (PhD)**



**Doctor of Technical Science**

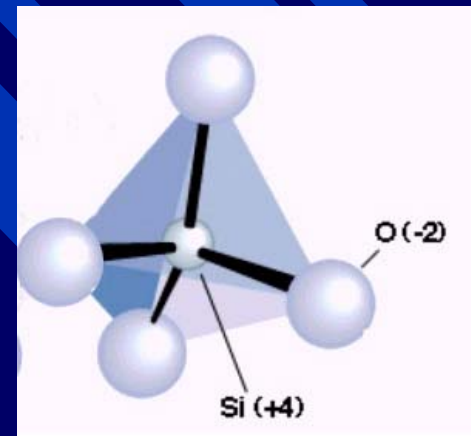


# Education Cycle

**B Sc program:**

– 240100 (580800)

***Chemical Technology  
and Biotechnology***



**M Sc programs:**

– 240100.31 ***Chemical Technology of the  
Refractory Non-Metal and Silicate Materials***

**Cand Sc (PhD) and Doct Sc programs**

***- 05.17.11 Technology of the Refractory Non-  
Metal and Silicate Materials***



# **List of subjects provides by Chair of silicates technologies (B Sc course)**

## **Natural Science disciplines**

- Mineralogy and crystallography;
- Physics and chemistry of solid state.

## **Common professional disciplines**

- The heat machines;
- Physics and chemical bases of silicate and inorganic materials technology.

## **Special disciplines**

- Physical chemistry of refractory non-metal and silicate materials;
- Thermal processes and apparatuses in technology of refractory nonmetallic and silicate materials;
- The equipment and bases of designing;
- Chemical technology of refractory nonmetallic and silicate materials

Chemical technology of binding materials;

Chemical technology of ceramics and refractory;

Chemical technology of glass and glass ceramics



## Training practice

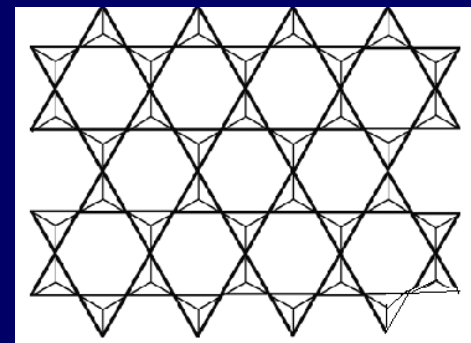
- Practical training / industrial practice
- Final work practice
- Interdisciplinary examination in the line of the bachelors training
- Pedagogical practice

## Final attestation (bachelor)

- Interdisciplinary exam
- Final qualification work

## Final attestation (master)

- State exam
- Final qualification work



# List of subjects provides by Chair of silicates technologies (M Sc course)

- Additional chapters in mathematic;
- Additional chapters in physical and colloidal chemistry;
- Modern problems of chemical technology;
- Thermodynamic of silicates and oxides;
- Physic and chemistry of nanomaterials;
- Physical and chemical basis of refractory non-metal and silicate materials technology;
- Crystal chemistry of silicates and oxides;
- Modeling of materials of silicates and oxides systems;
- Special chapters of physical chemistry of refractory non-metal and silicate materials;
- Synthesis and kinetics of phases formation of refractory non-metal and silicate materials;
- Theoretical bases of silicates technology;
- Physical and chemical methods for analysis of refractory non-metal and silicate materials;
- Technical petrography;
- Glasses and glass-like materials technology;
- Technology of fine and building ceramic;
- Cement technology;
- Scientific research work;
- Master dissertation preparation.

## Final attestation

- **Master's degree qualification.**



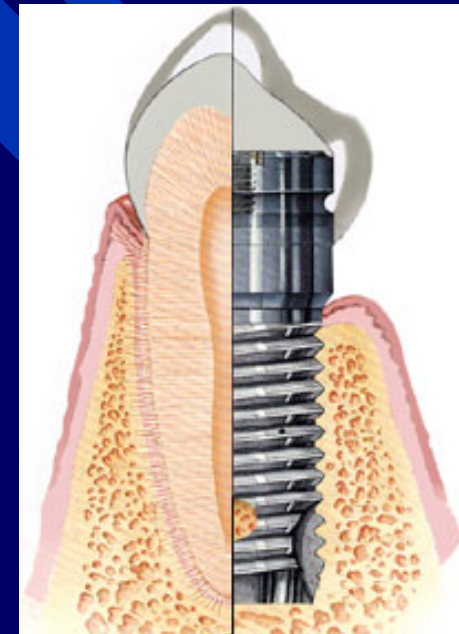
## **Building industry:**

- **High-Quality Wall and Fasade Construction Ceramics Made of Natural and Artificial Raw Material**
- **Thermo-Foam-Silicate Insulation Materials on the Base of Liquid-Glass Compositions**
- **Efficient thermo- and sound insulating porous materials**
- **Water solution for fire extinguishing**



# Medicine:

- Leucite-Hydroxyapatite-Fluorite Glass-Ceramics
- Biocompatible Coatings for Titanium Implants





# Metallurgy:

- Thermosilicate materials on the base of wollastonite compositions with lime-silica binder for aluminum production on the basis of zeolitic rocks
- Materials from the natural raw stuff for nonferrous metallurgy and oil and gas extraction branch



- **Ceramic Pigments on the Base of Natural Raw Material and Man-caused Waste. Development of Non-Traditional Method of Ceramic Pigments Obtaining**
- **Pretreatment of Glass Charges. Technology of Preparation and Compacting of Glass Charges**
- **Oxide-Nitride Precursors of Ceramic Materials**



# High-Quality Wall and Fasade Construction Ceramics

- **Field of application:** Architecture and construction
- **Purpose:** Compositions and technologies for the wall and fasade ceramic brick and plate with excellent technical and decorative properties made of natural, traditional, non-traditional and man-caused raw material of Siberian region
- **Raw materials:**
  - clay and loam
  - carbonate, wollastonite, zeolite, tremolite
  - fusible metallurgical slags
- **Brief description:** Construction and facing material for the outward walls and fasades
- Improving the decorative properties of the fasade ceramic brick can be performed by masking the red brick material by engobe coating or volume coloration



## ***Advantage:***

- Engobe coatings have various color palette and strongly bonded with base
- Volume colored brick has high stability (in comparison with the two-layer, engobe coated and glazed brick)
- Compression strength: 150–175 MPa
- Frost resistance: more than 35 cycles
- ***Commercial readiness:***
- civil and industrial engineering in the regions of Siberia and Far North



# Efficient thermo- and sound insulating porous materials on the basis of zeolitic rocks

- **Field of application:** Building construction
- **Purpose:** Granulated porous materials produced on the basis of zeolitic rocks for efficient thermo- and sound insulation in building construction. Material can also be used as a light weight filler for concrete
- **Brief description:** Mixture of the zeolitic rocks with the alkaline component allows producing granulated porous material:
  - Bulk density - 300-450 kg/m<sup>3</sup>
  - Compression strength - 4 – 6 MPa
  - Water absorption -14%
  - Temperature of process - 850°C
- The developed compositions and technologies of producing porous materials on the basis of zeolitic rocks in comparison with existing analogues allow to decrease the temperature of foaming from 1150-1200 °C to 800-900 °C. These materials surpass the nearest analogue 'foamglass' in strength and durability characteristics
- **Commercial readiness:** Experimental production



# Thermo-Foam-Silicate Insulation Materials on the Base of Liquid-Glass Compositions



- **Field of application:** Building; heat power engineering
- **Purpose:** The materials have a high-porosity rigid structure, and specified geometric form and sizes. There are to be used as insulation materials for housing and industrial buildings
- **Brief description:** Liquid-glass compositions are obtained by a direct dissolution of silica in sodium hydroxide, after that they are granulated. Granules distend in closed forms at 400 - 500 °C
- **Advantages:** The materials have low density (100 to 300 kg/m<sup>3</sup>) and low heat conductivity (0.05 to 0.08 W/m<sup>2</sup>K), not combustible. Ecologically pure product
- **Commercial readiness:** Experimental production



# Water solution for extinguishing the fire

- **Field of application:** Water solution is intended for extinguishing the fire and burning compounds being in different states of aggregation
- **Brief description:** Fire-extinguishing solution contains water and thickening addition (liquid glass with module 2.5 to 3.5) in following ratio:

water — 50 to 95 %

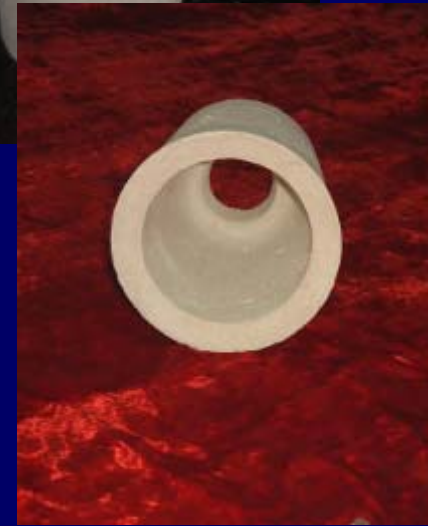
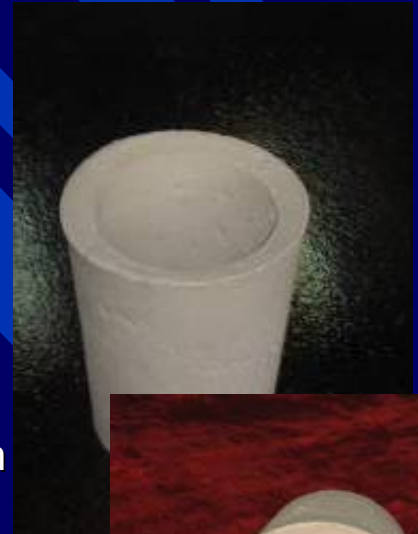
liquid glass — 5 to 50%

- **Advantages:** when the solution is put into the centre of fire, its temperature decreases as a result of water evaporation and formation of a solid layer of liquid glass foam
- **Commercial readiness:** the industrial production of the fire-extinguishing solution is possible



# Thermosilicate Materials on the Base of Wollastonite Compositions with Lime-Silica Binder for Aluminum Production

- **Field of application:** Lining of casted equipment, metal-path and other products for aluminum industry
- **Purpose:** Insulation, insulation-construction, and construction materials
- **Brief description:**  
Thermosilicate materials are produced on the base of wollastonite compositions with lime-diatomite binder and modifiers, depending on requirements of their usage in the aluminum industry
- **Properties:**
  - density 650-1500 kg/m<sup>3</sup>
  - compression strength 6 - 30 MPa
  - bending strength 4,5 - 27,3 MPa
  - thermostability - more than 30 cycles (in conditions of “heat-air”)
  - thermostability — more than 20 cycles (in the mode of “melting-air”)
- **Advantages:** Materials improves working characteristics of lining and other kinds of products, which work in contact with melted aluminum. Thermostability of such products is four times as much as then that of usual
- **Commercial readiness:** Experimental production



# Materials from the natural raw material for nonferrous metallurgy and oil and gas extraction branch

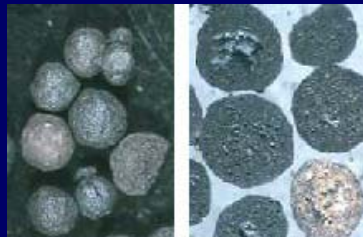
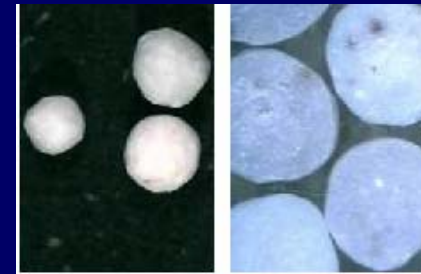
- **Purpose:** Barrier refractories and Silica-alumina ceramic propants for hydraulic fracturing of oil and gas stratum

- **The brief description:**

The high-density dry barrier mixes on the base of fire-clay.  $\text{Al}_2\text{O}_3/\text{SiO}_2$  are in the ratio from 0,42 up to 0,76. Material can be used for the lining of aluminium electrolytic cells

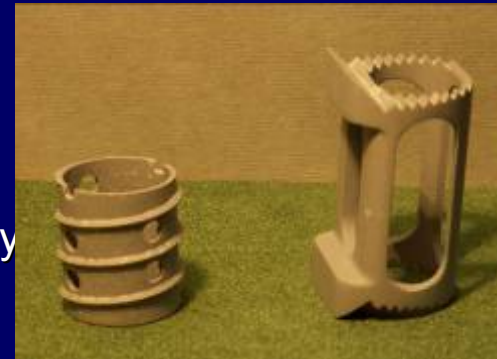
- Bulk density: less than  $157 \text{ kg/m}^3$
- Compression strength: 52-70 MPa

- **Commercial readiness:** The technology was tested at the some Russian factories



# Biocompatible Coatings for Titanium Implants

- **Field of application:** Surgery, traumatology, orthopaedy, stomatology
- **Purpose:** For biocompatible coatings of the titanium implants with high bioactivity in the human organism
- **Brief description:** The coatings have bioinductive and bioconductive properties. They promote osteosynthesis and the generation of the bone tissue in the contact with body liquid
- **Advantages:**
  - Biocoatings have strong biological fixation with bond tissue
  - Material fill up the local calcium and phosphorus lack, promote the growth of the bond tissue on the implant surface
  - Material promote the fast knitting of the bones
  - The fixity of biocoatings with the bond tissue increases from 3 to 5 times
- **Commercial readiness:** Coating surfacing technology



# Leucite-Hydroxyapatite-Fluorite Glass-Ceramics

- **Field of application:** Stomatology and surgery (coatings of surgical armaments), oncology

- **Purpose:** Glass-crystalline materials for medical use

- **Raw materials:**

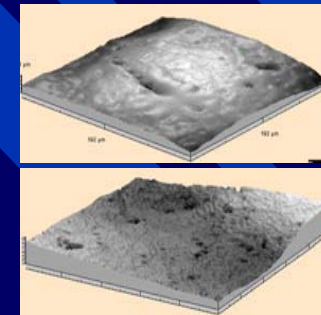
- potash feldspar
- natural hydroxyapatite

- **Brief description:** There are glass-crystalline materials on the base of leucite glass with additions of hydroxyapatite and alkaline metals and a some extenders. Hydroxyapatite percentage varies from 2 to 40 (depending on application)

- **Advantages:**

- Hydroxyapatite is used as substitute for traditionally in dental industry potentially dangerous compounds (for instance, tin oxide)
- Obtained material is biocompatible
- The coatings have high adhesion stability, chemical stability and microhardness, close to a natural tooth

- **Commercial readiness:** Experimental production



Dentine

without the crystal-nucleating agent

and after addition of crystal-nucleating agent



# Ceramic Pigments on the Base of Natural Raw Material and Man-caused Waste. Development of Non-Traditional Method of Ceramic Pigments Obtaining

- **Field of application:** Ceramics, porcelain and faience industry
- **Purpose:** For production of over-glaze and under-glaze paints, coloration of ceramic mass, glasses, glazes
- **Brief description:** Substitute of traditional materials to cheaper ones (natural mineral raw material and industrial waste)
- The use of natural crystalline structures gives a possibility to decrease the synthesis temperature and to widen colour palette
- **Advantages:** The use of natural mineral raw material and industrial waste and low synthesis temperatures allow to decrease the ceramic pigments expenses
- **Commercial readiness:** Experimental production



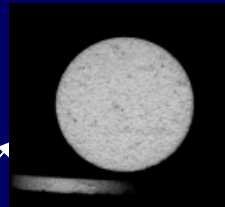
# Pretreatment of Glass Charges. Technology of Preparation and Compacting of Class Charges

- **Field of application:** New technologies of glass charges compacting for the production of different kinds of glass
- **Purpose:** The preparation of the compacted glass charges on the base of natural, usual and off grade raw materials, and also using man-caused waste
- **Brief description:** The technology of glass charges compacting, including:
  - different methods of granulation
  - the compaction in a roller-press
  - extrusion
- **Advantages:** The use of compact glass charges allows:
  - to decrease dust formation and the loss of fine-dispersed materials;
  - to exclude the materials conglomeration during the keeping;
  - to improve thermal properties of glass charges;
  - to decrease the fuel consumption;
  - to produce the compacted material of different shape (plates, granules);
  - to improve the working conditions and to solve ecological problems
- **Commercial readiness:** The technologies of glass charge compacting are used at a number of glass-works



# Oxide-Nitride Precursors of Ceramic Materials

- **Field of application:** Production of thermal resistant ceramics, microchip substrates, ceramic instruments for metal working, filter ceramics



Filter ceramics



Cutting tools



Catalyst carriers



# Oxide-Nitride Precursors of Ceramic Materials (continuation)

- **Purpose:** For different types of ceramics production
- **Brief description:** Ceramic materials precursors on the base of zirconium, aluminum, boron, titanium oxides and nitrides in the form of powder material. Material is obtained by the burning of metal powders. The metal nitride content: from 5 to 95 %
- Particle size of base material: 60-100 nm
- Particle size of the products: 0.1 - 10  $\mu\text{m}$
- Bulk density: 450 - 1050  $\text{kg}/\text{m}^3$
- **Advantages:** The use of precursors increases thermal conductivity, dielectric characteristics, endurance and thermal resistance of oxide ceramic materials
- **Commercial readiness:** Experimental production



# Chair of Silicates Technology and Nanomaterials (contact information)

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