INSTITUTE FOR SUPERHARD MATERIALS

DEPARTMENT OF SUPERHIGH PRESSURE TECHNOLOGIES, FUNCTIONAL STRUCTURED CERAMIC COMPOSITES AND DISPERSED MATERIALS

Who we are

The department is engaged in the development of high pressure (0.5 - 15 GPa) apparatuses of different types; manufacturing products using high pressure - high temperature technique, hot pressing, injection molding and pressureless and vacuum sintering; spark plasma sintering; in studying of structural peculiarities and properties of dispersed (micro-, submicro- and nanopowders of diamonds, cubic boron nitride, metals, metal alloys, oxides, carbides, heavy alloys, etc.), consolidated structural materials and nanomaterials (superhard, functional, superconducting, smart, transparent, cutting, refractory, oxide-, corrosion- and abrasiveresistant); superconducting and MAX-phases-based films; practical applications of materials .

Collaboration interests

Our department is interested in participating in EU projects under FP7 and other cooperation related to research areas listed below.
Potential role: major partner, scientific expert, test centre.

Research Areas

- Manufacturing of materials by:
  - high pressures-high temperatures technique
  - hot pressing
  - vacuum and pressureless sintering;
  - injection molding
- Investigation of the materials structure (X-ray, SEM, Auger)
- Testing of superconducting characteristics, electrical conductivity, thermoconductivity
- Mechanical properties study

Main achievements

- Designing and manufacturing of high pressure apparatuses (recessed-anvil-, toroid-, cube-, belt- and multianvil-types) able to create 1.5-15 GPa pressures in working volumes 1000 - 0.05 cm^3 with heating up to 1650 ^oC.
- Development of synthesis process and implementation into industry of powders of diamonds ASC15-ASC160 grades up to 600/500 μm and cubic boron LKV - KV grades up to 250/200 μm.
- Superconductive nanostructural MgB_2- and MT-$YBa_2Cu_3O_{7-\delta}$ - based materials with high functional performance for SC electromotors and inductive fault current limiters (or smart application).
- Oxidation-resistant refractory Ti_3AlC_2 nanolaminates with high damping ability and highly dense $Ti_2Al_{1.1}(C_xN_{(1-x)})_y$ MAX phases solid solutions.
- Constructional AlN-based ceramics with high-frequency wave absorption.
- Development of technological processes of large-dimensioned ring-shaped products (up to 300 mm) by hot pressing based on Si_3N_4, SiC, B_4C, MgB_2.
- Development and manufacturing of line of injection molding for products from micro- and nanodispersed refractory powders and their mixtures with thermoplastic materials.
- High efficient ceramic and tungsten-free hard-alloy cutting tools.
- Development of method of electro-erosion dispersion of micro and nano-powders of metals, metallic, hard and heavy alloys, oxides and carbides, etc.
- Development of processes of formation and optimization of chemical composition of dispersed composite materials (contained superhard materials, nanocarbon, etc.) for abrasive and boring instruments.

Reference projects

- INTAS-UKRAINE-95-0221 “High Pressure /High Temperature Preparation of Melt-textured YBCO High Temperature Superconductors for Cryomagnetic Applications”.
- NATO “Science for Peace” № 973529 project “High Melting Point Nanocrystalline Composite: the Materials of the New Millennium".
- STCU project 1836 **“**Gradient Multilayer Nanograined-composites Obtained by Advanced High-Pressure, Laser and Rate-Controlled Sintering”.
- STCU project 2592 “Promising functional nitride-based materials”.
- STCU project 3665 “Perspective nanostructural materials for cryogenic electrical machines”.
- Bilateral projects (devoted to super-conducting materials and MAX phases)
  Ukrainian- German (5 BMBF projects),
  Ukrainian - French (4 “Dnipro” projects),
  Ukrainian - Hungarian (3 projects),
  Ukrainian -Greece (1 project),
  Ukrainian - Austrian (3 projects).

Contact information

Full name of the Research Department: Department of Superhigh pressure technologies, functional structured ceramic composites and dispersed materials.
Full name of the Institute: Bakul Institute for Superhard Materials of the National Academy of Sciences of Ukraine.
Number of employees working in the research division: 51.
Working languages: Ukrainian, Russian, English, German.
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Available equipment and experience in high pressure, hot pressing, SPS, HIP, vacuum, pressureless sintering technologies.
Experience in material science and manufacturing of nano- and micro powders, consolidated ceramic materials and thin films, materials applications.
Structure and properties study.
Experience in scientific cooperation with EU and other countries.