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HIGH-PERFORMANCE and SUSTAINABLE COMPOSITES INNOVATION WORKSHOP
TU DRESDEN 13-14.10.2022

Frantsevich Institute for Problems of Materials Sciences of
National Academy of Sciences of Ukraine
Dr. Iryna Bilan
Ukraine

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958255

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IPMS NASU main scientific areas:

- Physical and chemical basis for inorganic materials formation technologies, study of phase equilibria, surface and contact phenomena in multicomponent systems
- Strength physics, creation of structural materials with high specific strength, nanocrystalline metals
- **Advanced powder metallurgy technologies, metal-based materials and composites and powder coatings**
- **High temperature composite materials, non-oxide ceramics and cermets**
- **Consolidated and dispersed nanostructured materials, nanoceramics and nanocomposites**
- Hydrogen material science and hydrogen technologies for material production and processing
- Biomaterials and biotechnologies

Research and development in the field of Materials Science and Advanced technology of Metal, Ceramic and Composite materials.

- IPMS NASU founded in 1952
- 800 research stuff, including 60 Dr.Sci. and 200 Ph.D.;
- 30 departments;
- 15 research laboratories;
- Special Design Bureau with Pilot Plants.

www.materials.kiev.ua

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HORIZON-CL4-2023-TWIN-TRANSITION-01-31:

ENERGY EFFICIENCY BREAKTHROUGHS IN THE PROCESS INDUSTRIES (PROCESSES4PLANET PARTNERSHIP) (RIA)

Production technology of self-healing ceramic composites Si3N4–MeN (where Me is Ti and Zr) :

Development of novel powder synthesis methods, methods of their consolidation, production of coatings

Based on up-to-date methods of Microwave sintering, Spark Plasma Sintering and Rate-Controlled Sintering.

Developed self-healed composites help to increased service life in extreme operating conditions under the action of aggressive media (gaseous and liquid) at high temperatures and loads without additional environmental footprint.

Elements of the bearing - ceramic balls can be received. A hybrid bearing for bench tests can be assembled. The resulting product can operate for a long time in an oxidizing environment at temperatures up to 500-700 ^{o}C without oil.

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ENERGY EFFICIENCY BREAKTHROUGHS IN THE PROCESS INDUSTRIES (PROCESSES4PLANET PARTNERSHIP) (RIA)

Development of a manufacturing technology of Si3N4–MeN (where Me is Ti and Zr) composite disperse powders in a wide concentration range not requiring milling for high-temperature coatings and ceramics.

Composite powders of nitride ceramics are recommended for deposition of coating and manufacture of three-dimensional products, e.g., bearings with the self-healing effect and ***increased service life*** *in extreme operating conditions under the action of aggressive media (gaseous and liquid) at high temperatures and loads.*

The use of modern methods of deposition of coatings and sintering makes it possible to obtain dense composite nitride ceramics with increased physicomechanical properties (hardness, density, and fracture toughness) as compared with those of silicon nitride, which will ***provide an extended service life of parts and mechanisms.***

The proposed technology is ***ecologically friendly due to the absence of evolution of toxic gases*** *into atmosphere and the use of safe initial components and production waste as compared with those in sol-gel technologies for obtaining such compounds.*

The economic significance of this technology is ***the reduction of the electric energy consumption by 20%*** *due to a decrease in the number of technological operations, the absence of long-term mixing processes of initial components (up to 60 h) and of the milling process of synthesized products as compared with traditional methods, which include long-term mixing processes of commercial silicon nitride and metals powders.*

Industrial partner that may take part in the project: JSC“NanoTechCentre” – development of composite nanopowder synthesis methods.

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HORIZON-CL4-2024-RESILIENCE-01-24:
DEVELOPMENT OF SAFE AND SUSTAINABLE BY DESIGN ALTERNATIVES (IA)

Contribution concerns advanced composite materials for components of solid oxide fuel cells (SOFC) and energy systems based on SOFC

Production of Ti-based composite materials for interconnects of SOFC-based energy systems

*Ti-based materials not only **decrease weight of energy system in twice**, but also, they would allow to **completely eliminate the chromium poisoning problem** during SOFC operation and facilitate developing of commercial attractive light-weight SOFC stacks for mobile systems*

Within the framework of project, it is proposed

- *to develop the synthesis method of Ti-based composite powders;*
- *to perform synthesis of further powder of Ti-based composite;*
- *design of single cell system based on light weighted interconnect;*
- *perform testing of the developed single cell system.*

Industrial partner that may take part in the project: STC “NOVITECH” – combined and heat power fuel cell energy systems; Science and Industry Company “TEKHNOPLAN” – ceramic fuel cells testing

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HORIZON-CL4-2024-RESILIENCE-01-24:

DEVELOPMENT OF SAFE AND SUSTAINABLE BY DESIGN ALTERNATIVES (IA)

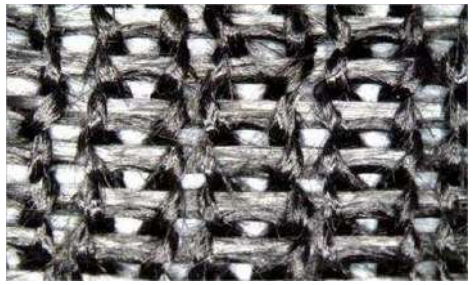
Weft-knitted complex fillers from from high strength carbon and chemical fibers and metal microwires (carbon, glass, Teflon and etc.) for production of polymer-based composites.

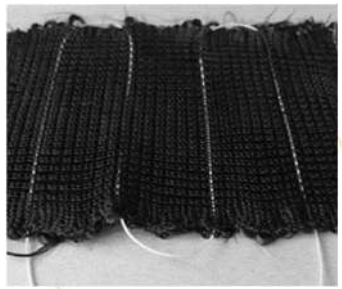
The new filler for polymer-based composites may contain a fiber-optic built-in control system (monitoring and on-line process control) - an optical cable is laid in the weft with a certain step.

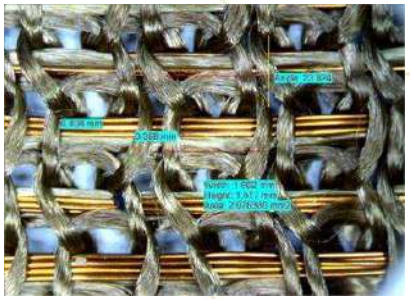
It allows to arrange the sensors in knitted fabric structure without a gap and thus reducing possible measurement errors.

Electrotechnical materials are promising for use in engineering, for example, as flexible textile heater for voltages of 12, 24, 36V, where the role of a heating element is played by a carbon thread laid in a weft. Another opportunity is the using of thin metal wires.

Potential Industrial partners : SDO Pivdenne, JSC Antonov, PBSC Motor- Sych







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HORIZON-CL4-2023-TWIN-TRANSITION-01-31
HORIZON-CL4-2024-RESILIENCE-01-24

RELEVANT EQUIPMENT AND FACILITIES

Self-healing materials*:*

- *Pulverisette 6 planetary mill and high energy ball mill for mechanosynthesis of powders and preparation of powder mixture,*
- *high temperature microwave sintering furnace (1200 °C), SNOL high temperature electric furnace (up to 1100 °C), CHBE(1600 °C) and SCHVL (2200 °C) vacuum-gas furnaces, HPD25 spark plasma sintering furnace,*
- *drying oven SP-50, vacuum drying oven,*
- *thermostat, X-ray difractometer,*
- *"Ceram Test System" mechanical test system, PMT-3 and MMT-3 hardness testers,*
- *ultrasonic resonance testing system, and static-dynamic loading wear testing complex.*

Composites for SOFCs:

Equipment for powder synthesis, equipment for testing of single cell

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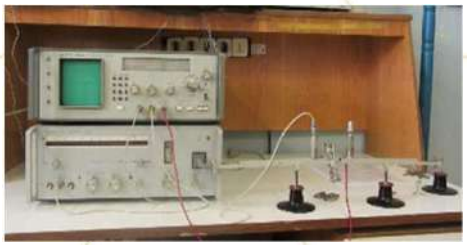
RELEVANT EQUIPMENT AND FACILITIES

Complex fillers for polymer-based composites:

- *Modernized flat-knit knitting machine (allows processing of fragile threads (with a large number of filaments) or large diameter yarns that cannot be looped by a conventional knitting machine.*
- *Equipment for testing of physical and mechanical properties*
- *Investigation of electrical resistivity of knitted materials*
- *Study of shielding properties of fillers and polymer-based composites, reinforced by this filler*



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