PERSPECTIVES OF IPMS NASU INTERNATIONAL COOPERATION WITHIN THE FRAMEWORK OF HORIZON-EUROPE OPEN CALLS

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OUTLINE

- General overview
- Main research areas and scientific topics
- Communication background
- International cooperation
- Capabilities within the framework of some Horizon Europe open calls

IPMS NASU GENERAL OVERVIEW

- Frantsevich Institute for Problems of Materials Science of National Academy of Science of Ukraine(IPMS NASU) is a leading academician Institute in the field of materials science and advanced technology of metal, ceramic and composite materials
- IPMS NASU had been founded in 1952 on the base of laboratory of special alloys and started its activity at the territory of Kyiv-Pechersk Lavra
- IPMS NASU employs about 900 people, who work in 30 scientific departments, among them 70 doctors of sciences and about 200 PhD.
- IPMS NASU is the strong material science complex of full cycle:

❖ *development of scientific basis of creation of materials with given complex of exploitation parameters (theoretical background, many factor modelling);*

❖ *production of powders, coatings, articles from metals, ceramic and composites, reinforced by particles, fibers, nanoadditives;*

❖ *characterization of produced samples by SEM (center TEM-SCAN), element and isotope analysis of materials, mechanical testing of materials for normal and extreme conditions;*

❖ *production of test samples for industrial partners (Design Bureau Yuzhnoye, Antonov complex*

IPMS NASU MAIN RESEARCH 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

IPMS NASU COMMUNICATION BACKGROUND

- IPMS NASU - organizer of the Ukrainian Materials Research Society (UMRS), which comprises 20 regional subdivisions covering the whole of Ukraine (Kharkiv, Dnipro, Lviv, Donetsk, Chernovtsy, Odessa, Zaporozhye, etc). www.umrs.org.ua
- IPMS NASU- founder of Ukrainian Technology Platform on New Materials and Perspective Technologies of their Production (UTPNM) which combines the efforts of the members of academic, public and industrial representatives on practical implementation of the results of researches http://www.materials.kiev.ua/sait_platforma/ass.html
- IPMS is FP7 National Contact Point for the priority NMP, the Horizon 2020 National Contact Point for the priority "Nanotechnologies, Advanced Materials, Biotechnology, and Advanced Manufacturing and Processing-NMBP". The list and new titles of National Contact Point in Horizon Europe Framework Programm will be confirmed during nearest time
- IPMS NASU – organizer of 2 or three international conferences per year (HIghMatTech, Materials and coatings for extreme environments, Samsonov conference on material science of refractory compounds and composites) with more than 100 participants for each case
- The director of the institute academician of NASU Yu.M.Solonin – is the leader of targeted NASU scientific program "Development of scientific principles for hydrogen production, storage and use in autonomous energy supply systems» http://www.materials.kiev.ua/Hydrogen_2019-2021/index.htm

IPMS NASU INTERNATIONAL COOPERATION

- IPMS NASU – active participant of **bilateral projects**:

Lightweight interconnect Ti-Si-C for solid oxide fuel cell application (2019-2021pp.) (Technology University, Brno, Czech Republic);

Synthesis and sintering of phases with a perovskite structure based on lanthanum and lutetium oxides doped with phosphors for optically transparent ceramics based on them (2019-2020pp.) (Scientific and practical Center, Minsk, Belarus);

Development of fundamental bases of creation of composite materials (aluminum matrix strengthened by nanoquasicrystals) for work at the raised to 300 ° C temperatures taking into account specific features of plastic deformation of these materials (2020-2021pp.) (Institute of applied physics, Minsk, Belarus)

Investigation and development of microwave composites with increased wear resistance (2020-2021)(Technology Institute,Rurka, India)

- IPMS NASU – participant **STCU partnership projects**:

Principle approach and development of new superhard nanocomposite coatings (2018-2019) (Technology Institute, Munich, Germany, Livermol Laboratury, USA);

Development of new equiatomic multicomponent cast structural alloys in the nanocrystalline state (2018-2020) (Kharkov Physical and Technical Institute, Kharkov,Ukraine);

IPMS NASU INTERNATIONAL COOPERATION

- IPMS NASU – active participant **NATO Science for Peace Program** (SPS) projects:

Advanced Material Engineering to Address Emerging Security Challenges (2020–2023) (Rutger University, USA);

Laser Ceramics for Detector of Harmful Substances (2020-2023) (Fraunhofer Institute of Ceramic Technologies and systems, Germany)

Portable energy supply (2017-2020), Energy Institute, Norway)

- IPMS NASU – participant **FP7 Framework Program** projects

signed grants – 4, EC contribution-1,04 M €

1.Super light-weight thermal protection system for space application (2014-2017) –priority space

2. Stimulating Ukraine - EU Aeronautics Research Cooperation (2009-20011)- priority transport

3. Functionalised Innovative Carbon Fibres Developed from Novel Precursors With Cost Efficiency and Tailored Properties (2014-2017)-priority NMP

4. Deployment of Societally Beneficial Nano- and Material Technologies in European Partnership Countries (2013-2015)-priority NMP

Horizon 2020 Framework program:

15 proposals prepared and submitted, including 3 proposals on NMBP progra

all rejection decisions *unfortunately*.

HORIZON-CL4-2022-RESILIENCE-01-12: Functional multi-material components and structures (RIA)

- ***Scope*: By combining several materials, proposals should advance the state of the art through the development of ready assembled multifunctional devices. The role of new development in additive manufacturing processes with dissimilar materials will be of importance.**
- **Proposed contribution**:

The technological development of printing pastes with different composition 3-D Robocasting and Fused Deposition Modelling (FDM) is proposed.

*The synthesis of fine powders of high-melting-point ceramic composites for 3D printing (Robocasting and FDM) and the development of **hybrid polymer-ceramic materials** (PP-Si3N4, PP-TiN, etc.) for FDM printing.*

Development of technological approaches to heat treatment of Robocasted green pellets using microwave and rate-controlled sintering.

Using the non-distructive method of diagnostics of 3D printed parts such as indentation methods under static and dynamic loading by friction and scretch tests it is possible to investigate tribological properties of 3D printed parts.

Detailed information on mechanical properties of 3D printed specimens, such as strength, Young modulus, and degree of anisotropy will be provided by ultrasonic non-destructive testing.

The list of all necessary equipment for production and testing is available in laboratory

HORIZON-CL4-2022-RESILIENCE-01-12: Functional multi-material components and structures (RIA)

- ***Outcomes** : **contribute to energy efficiency, increase competitiveness of new multi-materials items and multi-functional materials,.. develop optimised structures in terms of operational performance , …. reduced lead-time of multimaterial products of 20% compared to today's design***
- **Proposed contribution**:

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.*

HORIZON-CL4-2022-RESILIENCE-01-11. Advanced lightweight materials for energy efficient structures (RIA)

- ***Scope: A step change is needed to develop new sustainable and high performance lightweight materials and associated novel manufacturing techniques which comply with industrial demands for quality and reliability*.**
- **Proposed contribution**

Contribution concerns advanced 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*

It is proposed within the framework of project

- ✓ *to develop the synthesis method of powder of Ti-based composite;*
- ✓ *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.*

HORIZON-CL4-2022-RESILIENCE-01-13: Smart and multifunctional biomaterials for health innovations (RIA)

- **Expected Outcome**: **Multi-functional biomaterials** are capable, by virtue of their own material ingredients or surface properties, of achieving several biological responses simultaneously. They may also help to dampen those that are undesirable such as inflammation, infection, corrosion and issues related to bio and immune compatibility, **while taking into account the specificities due to sex, race and age**.
- **Proposed contribution**

Develop new bioceramics based on nanostructured biogenic hydroxyapatite, modified with graphene-like structures with improved performance properties by CVD-method due to the positive combination of unique properties of graphene-like structures and biogenic natural analogue of bone tissue.

Inexpensive and widely available starting materials, simplicity and low energy consumption for production provide a reduction in the cost of bioceramics.

*The obtained materials will have a wide range of applications **with the possibility of selection** depending on the age and traumatic characteristics of patients to accelerate the processes of bone regeneration and reduce rehabilitation time of patients.*

All production and testing equipment is available

THANK YOU FOR YOUR ATTENTION!

SUCCESSFUL PROPOSALS AND PROJECTS FOR YOUR TEAMS!

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