

Project P640. Super light-weight thermal protection system for space application - SRI

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Outline

- Introduction.
- Organization, qualification and staffing. Who are we ?
- Facilities.
- Participants of your project.
- Qualification with references to previous significant results and what they will do in the project.
- How does this project relate to our other work ?
- Conclusions.

Introduction

- This report focuses on our organization, qualification and staffing.
- Modeling and optimization methods.
- Super lightweight material.
- Modeling of graphene superlight material.
- Nanosized materials for space application.
- Additionally, there is a pervasive interest across diverse application areas such as energy storage systems based on nanosized materials, metal-semiconductor contact of zigzag/armchair SWCNTs, and superconducting materials.

Organization, qualification and staffing. Who are we ?

Space Research Institute (SRI) was founded by the joint decision of the National Academy of Sciences of Ukraine and the National Space Agency of Ukraine. It was formed for organization and realization of purposeful scientific space researches, coordination of scientific and technical activity in the area of space research in Ukraine. The key areas: (1) space material science; (2) mathematical modeling super light-weight materials for space applications; (3) advanced instrumentation; (4) space information systems and technology; (6) aerospace data processing technologies.

Organization, qualification and staffing. Who are we ?

SRI participates in the national and international research projects on the near-Earth space: VARIANT (on board SIC-1), POTENTIAL (on board SIC-2), IONOSAT (in preparation), as well as RADIOASTRON, RESONANCE, PHOBOS-GRUNT.

In Earth Observation: methodological support and development of information services within the framework of GEO-UA program; coordinates the Russian-Ukrainian program on cooperation in the exploration and use of outer space for peaceful purposes in 2012-2016 years.

Organization, qualification and staffing. Who are we ?

SRI represents Ukraine in international space organizations and working groups (COSPAR, CEOS, GEO). UN-SPIDER (United Nations Platform for Space-Based Information for Disaster Management and Emergency Response) regional support center was established on the basis of SRI NAS and NSA of Ukraine.

SRI includes 6 research departments, employs nearly 100 staff among them: 1 member of the National Academy of Sciences of Ukraine, 1 member-corr. of the National Academy of Sciences of Ukraine, 13 Doctors of sciences (professors), 17 candidates (Ph.D.).

Facilities

- Windows computers;
- Software systems for research projects (MATLAB, FORTRAN, Python);
- Molecular modeling software (MOPAC, GAUSSIAN, HyperChem, Chem3D);

FP-7 Space Program

Existing projects

ROV-E Lightweight Technologies For Exploration Rovers

AFFECTS Advanced Forecast For Ensuring Communications Through Space

POPDAT Problem-oriented Processing and Database Creation for Ionosphere Exploration

SIDER Radiation Shielding Of Composite Space Enclosures



OPERR Operational Pan-European River Runoff

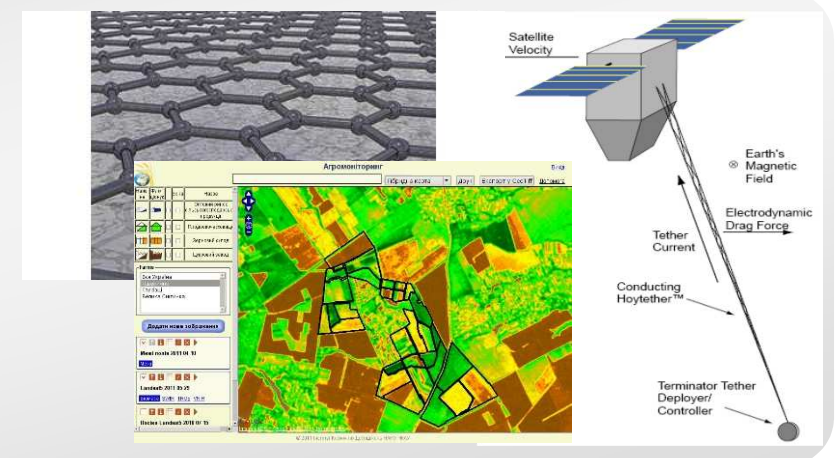
HPH Helicon plasma hydrazine combined micro

MYOCEAN Development and pre-operational validation of upgraded GMES marine core services and capabilities

MYOCEAN-2 Prototype Operational Continuity for the GMES Ocean Monitoring and Forecasting Service

Perspective areas of research within further calls

- **GMES services for agricultural needs**
- **Super light materials and covers for space-based systems**
- **Methodologies and technologies for active removal of space debris**

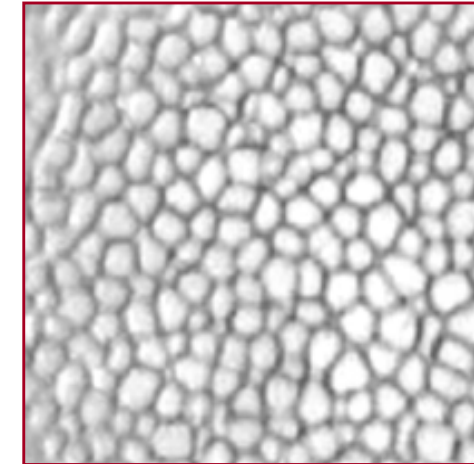
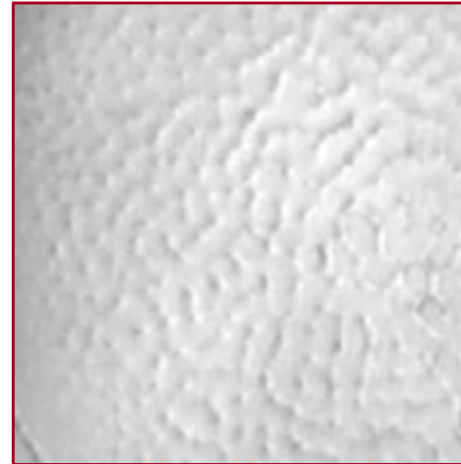
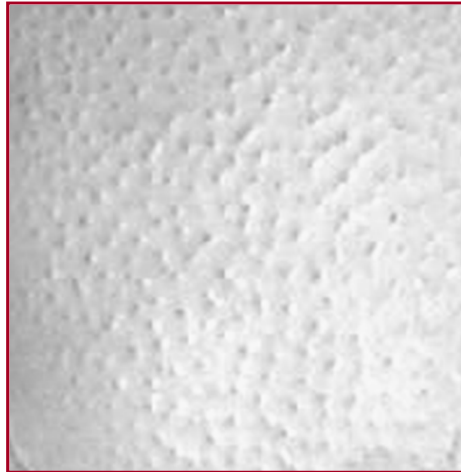


The solidification front morphology



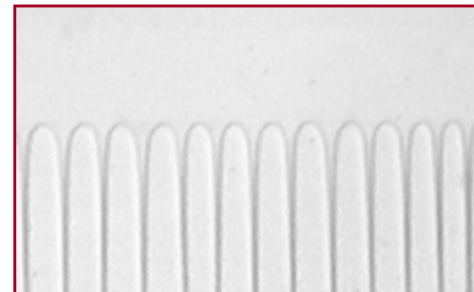
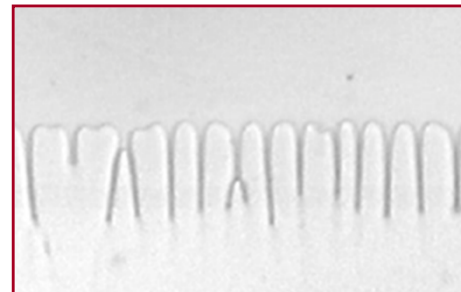
Succinonitrile, $\langle 100 \rangle$

bulk
sample



$V = 1.1 \text{ mm/s}$

Plane
sample



$V = 0.68 \text{ mm/s}$

Projects

1. Research project "**Conducting versus insulating abilities of ethylene-glycol oligomers**" from the *Royal Swedish Academy of Sciences* (**1999**), University of Linköping (Sweden). Project manager: **Bo Liedberg (Linköping , Sweden)** ;
2. INTAS grant "**Single electron transport in molecular cluster nanostructures and devices**" (**2000-2002**), Project manager: **Lars Samuelson (Lund, Sweden)**;
3. Research project "**Quantum conductance of molecular wires**" from the *Royal Swedish Academy of Sciences* (**1998-1999**), *University of Linköping* (Sweden). Project manager: **Karl-Fredric Berggren (Linköping , Sweden)**;
4. KVA project "**Metal-semiconductor contact of zigzag/armchair SWCNTs: study of current quantization in a real system**" of the *Royal Swedish Academy of Sciences* (**2004**) University of Linköping (Sweden). Project manager: **Sven Stafstrom (Linköping , Sweden)**;
5. Visby Program "**Design and Characterization of Nanoscale Architectures for Next Generation of Bioanalytical and Medical Applications**" supported by the *Royal Swedish Academy of Sciences* (**2005**). Project manager: **Bo Liedberg (Linköping , Sweden)**.
6. NTCU project "**Development and design of energy storage systems based on nanosized materials for space applications**" (**2012-2013**)

Participants of your project

- Professor Vitaliy Yatsenko
- Dr. Oleh Fedorov
- Dr. Yuriy Klymenko
- Ing. Raisa Zvetkova

Dr. Oleh Fedorov

Education: Kyiv State University, General Physics:

Ph.D. Degree in Phys. and Math. (Crystallization), Institute for Metal Physics, National Academy of Sciences), 1982;

Doctor in Phys. and Math. (Crystallization) Institute for Metal Physics.

Affiliation: Director of the Space Research Institute NAS and NSA of Ukraine.

Achievements:

Winner of State Prize of Ukraine in the field of Science and Technology (2008), corresponding member of the International Academy of Astronautics.

Represents Ukraine at the International committee on Space Research, COSPAR, International organizations, CEOS, GEO, GES.

SPHERE OF INTERESTS

Space Material Science, Space Programming, Management of Space Projects

other fields

Solid State Physics, Crystal Growth
Analysis of Space Activity, Space
Material Science

Dr. Vitaliy Yatsenko

Yatsenko Vitaliy is PhD and Doctor of Sciences. He is head of department "Remote Sensing Methods and Advanced Instrumentation" at the Space Research Institute of NASU-NSAU. Dr. Yatsenko is a world leading expert in space material science, intelligent sensors and nanodevices for space applications. His recent research interests include super light-weight materials, nanotube technology, nanoelectronics, mechanical and actuation behavior of nanostructured polymers, integration of carbon nanotubes into electromechanical sensors, and ultracapacitor modelling. He took part in the grants supported by the following organizations: NATO, CRDF, and Science and Technology Centre of Ukraine. He participated in 2 international research grants in the field relevant to the Project and nanotechnologies. Namely, in research STCU projects "Applying the GRID-technology for making complex calculations in condensed matter physics and nanophysics" (2009-2010) and in "Development and design of energy storage systems based on nanosized materials for space applications" (2012-current). Overall number of publications is more than 270.

Dr. Yuriy Klymenko

senior researcher of department
"Remote sensing methods and
advanced instrumentation"



- Background in theoretical physics;
- Research interests: solid state physics, new materials, molecular electronics and sensorics, electron properties of nanostructures, polymers, and nanocomposites, vibration spectroscopy;
- Published more then 45 papers;
- Experience in programming (FORTRAN, MATLAB) and molecular modeling software (MOPAC, GAUSSIAN, HyperChem, Chem3D, etc);

References

1. In-situ observation of solid-liquid interface during directional solidification in succinonitrile and pivalic acid. *Microgravity Science and Technology*, V.16, N1, 2005, P. 107-110. A.P. Shpak, O.P. Fedorov, E.L. Zhivolub, Y.I. Bersudskyy, O.V.Shuleshova.
2. Interface morphology during growing single crystals of different crystallographic orientations. *J. Cryst. Growth.*, 2006, V.122, N 4, P.112-118. O.P. Fedorov, A.P. Shpak, O.V. Shuleshova, V. Yatsenko.
3. IONOSAT - Ionospheric satellite cluster. *Advances in Space Research*, 2008, V.42, N 9, P.1515-1522. V. Korepanov, G. Lizunov, O. Fedorov, Yu. Yampolsky, V. Ivchenko.
4. Space experiment "Potential" on board Sich-2 satellite. *Kosmichna nauka i tehnologiya (Space Science and Technology)*, in Russian, 2008, V. 14, N 4, P. 3-8. Lizunov G.V., Glemba V.I., Korepanov V.E., Kryuchkov E.I., Lukenyuk A.A., Skorokhod T.V., Fedorov O.P., Shuvalov V.A.
5. Use of Satellite and In-Situ Data to Improve Sustainability. *NATO Science for Peace and Security Series C: Environmental Security*, 2011. Kogan F., Powell A.
6. Processes of crystal growth: kinetics, shape, heterogeneity. *Naukova dumka*, Kyiv 2010, 207 p. O.P. Fedorov.

References (cont'd)

- Onipko A, Klymenko Yu., Berggren K.-F., Malysheva L., Rosink J.J.W.M., Geerligs L.J., Van der Drift E., and Radelaar S. *Scanning tunneling spectroscopy on π -conjugated phenyl-based oligomers: a simple physical model.* **Phys. Rev. B**, 2000, 62, P. 11118-11124.
- Klymenko Yu.O. *Low-energy electron transmission in a partially unzipped zigzag nanotube.* **Eur. Phys. Journal**, 2010, B77.- P. 433-440.
- V. Yatsenko et. al. *Space weather influence on power systems: prediction, risk analysis, and modeling // Energy Systems.*- Springer.-2010.-Vol. 1, N2. - P 197-207.

Conclusion

- The system analysis has been conducted to creation of new methods for detection of the biological and chemical agents concentration across several different sensor stages.
- The conception of the hyperspectrometer has been proposed. It is based on the novel principles of information processing.
- The hyperspectrometer is elaborated on the basis of:
 - 1) optical and information technologies;
 - 2) most informative characteristics of spectral curves.

Thank you for coming!

