State Program on Nanotechnologies and Nanomaterials: Integrating Research, Innovation and Education

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Outline

1. Reforms in science in the Republic of Moldova
2. Innovative system
3. Scientific educational cluster UnivER SCIENCE
4. Nanoscience and nanotechnologies: main players
5. State program on nanotechnologies and nanomaterials
6. Some important projects
7. Conclusions

Reforms in Science

The Code on Science and Innovation

Ratified by the Parliament on July 15, 2004

The Code is a unique legislative document, which regulates relationships in the sphere of science and innovation

According to the Code

- **The Academy of Sciences** becomes **the unique public institution** of national importance in the field of science and innovation.

- **The Academy of Sciences** is authorized with **the Government's competence** in the field of scientific research.

The Academy of Sciences of Moldova, as a public institution, in compliance with the Code, had concluded a

Partnership Agreement

with the Government of the Republic of Moldova

Partnership Agreement Stipulates:

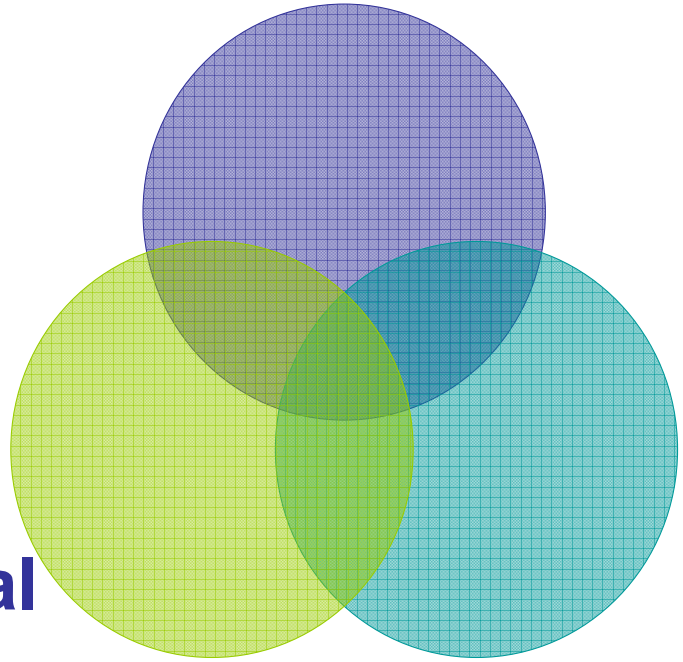
- **The level of financial support of Science and Innovation fields;**
- **Strategic Priorities concerning the Development of Science and Innovation fields;**
- **The reorganization of science and innovation fields.**

National Programs in Science and Innovation

- State Programs (10 State Programs)
- Program for Young Scientists
- Program for Equipment Purchasing
- Program for Technology Transfer Projects

Innovative system of the Academy

Agency for Innovation and Technological Transfer



Scientific Technological Parks

Innovation Incubator

LAW ON TECHNOLOGY PARKS AND INNOVATIVE INCUBATORS

No. 138-XVI of 21.06.2007

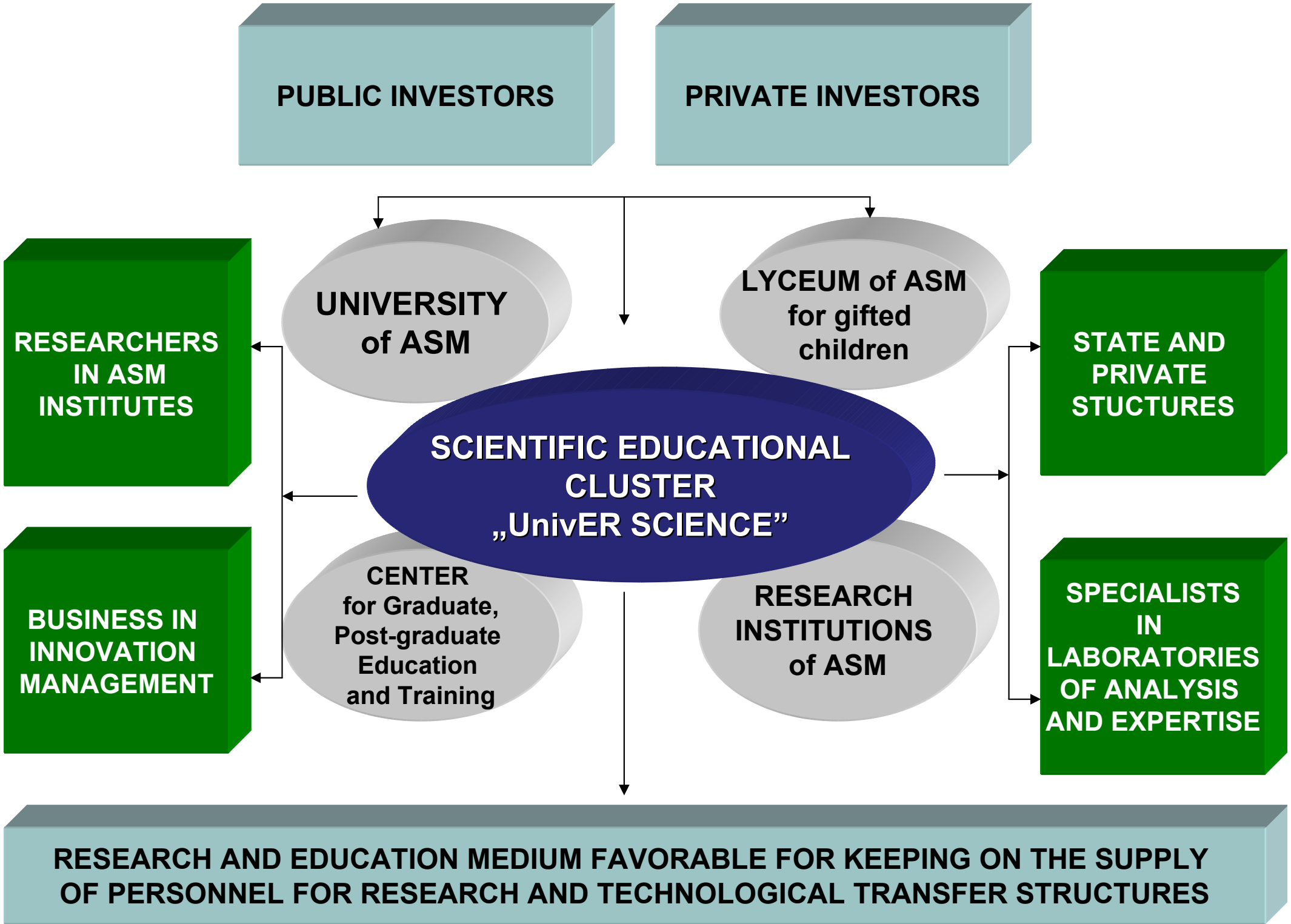
Important peculiarities

1. Geographical freedom.
2. Fiscal and customs facilities:
   - Exemption from payment of VAT (20%) on goods and services imported from abroad;
   - Exemption from payment of VAT (20%) on goods and services bought on the territory of the Republic of Moldova;
   - Exemption from payment of customs taxes (5%) on imported goods and services.

Scientific educational Cluster
of the Academy of Sciences of Moldova

„UniVER SCIENCE”

Education through RESEARCH


PUBLIC INVESTORS
PRIVATE INVESTORS
RESEARCHERS IN ASM INSTITUTES
UNIVERSITY of ASM
LYCEUM of ASM for gifted children
STATE AND PRIVATE STUCTURES
SCIENTIFIC EDUCATIONAL CLUSTER „UnivER SCIENCE”
BUSINESS IN INNOVATION MANAGEMENT
CENTER for Graduate, Post-graduate Education and Training
RESEARCH INSTITUTIONS of ASM
SPECIALISTS IN LABORATORIES OF ANALYSIS AND EXPERTISE
RESEARCH AND EDUCATION MEDIUM FAVORABLE FOR KEEPING ON THE SUPPLY OF PERSONNEL FOR RESEARCH AND TECHNOLOGICAL TRANSFER STRUCTURES

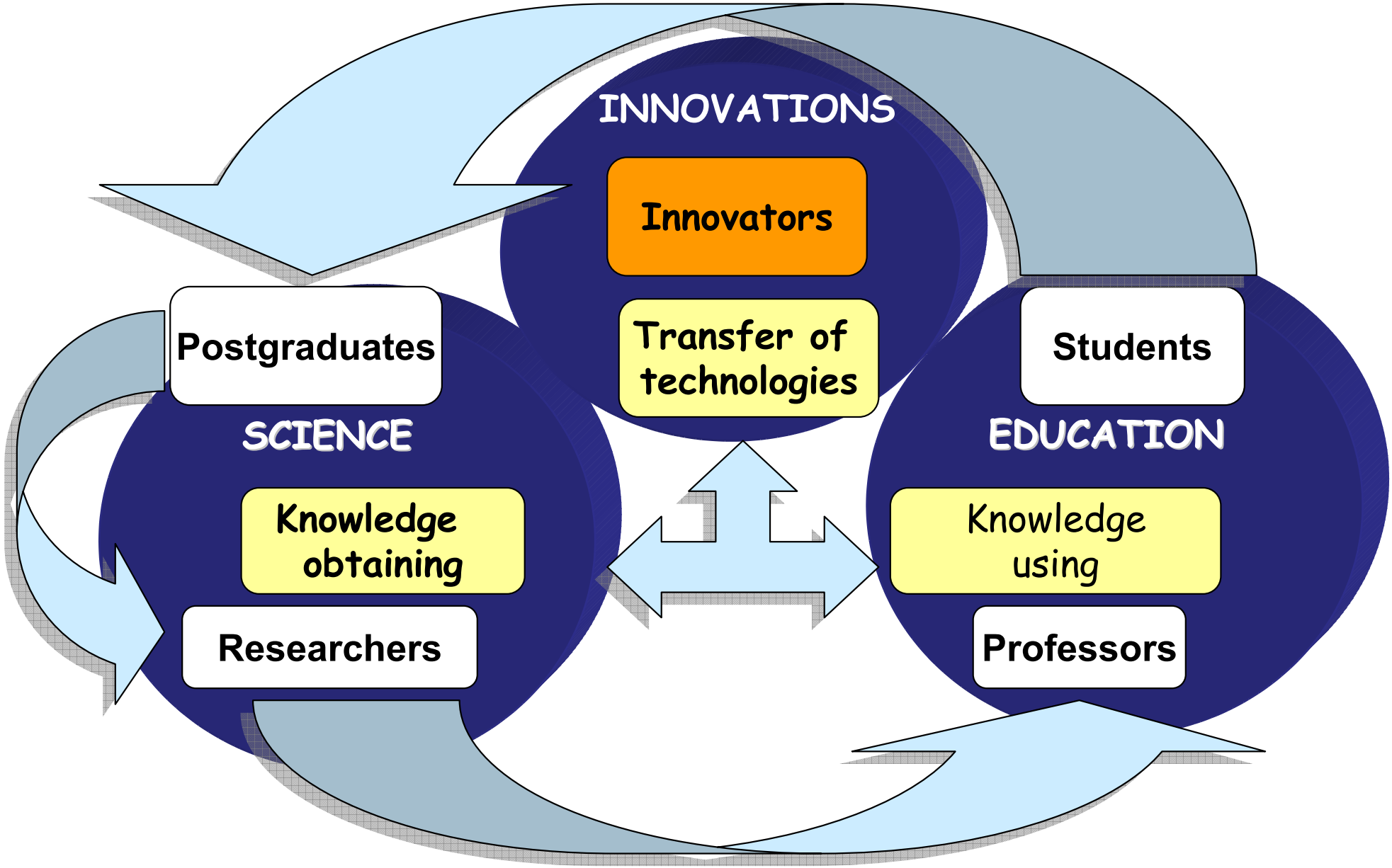
Nucleus of the CLUSTER

- Lyceum of ASM for talented children;
- University of ASM;
- Research institutions;
- Scientific technological parks;
- Innovative incubator.

SPECIFIC OBJECTIVES OF THE SCIENTIFIC EDUCATION CLUSTER

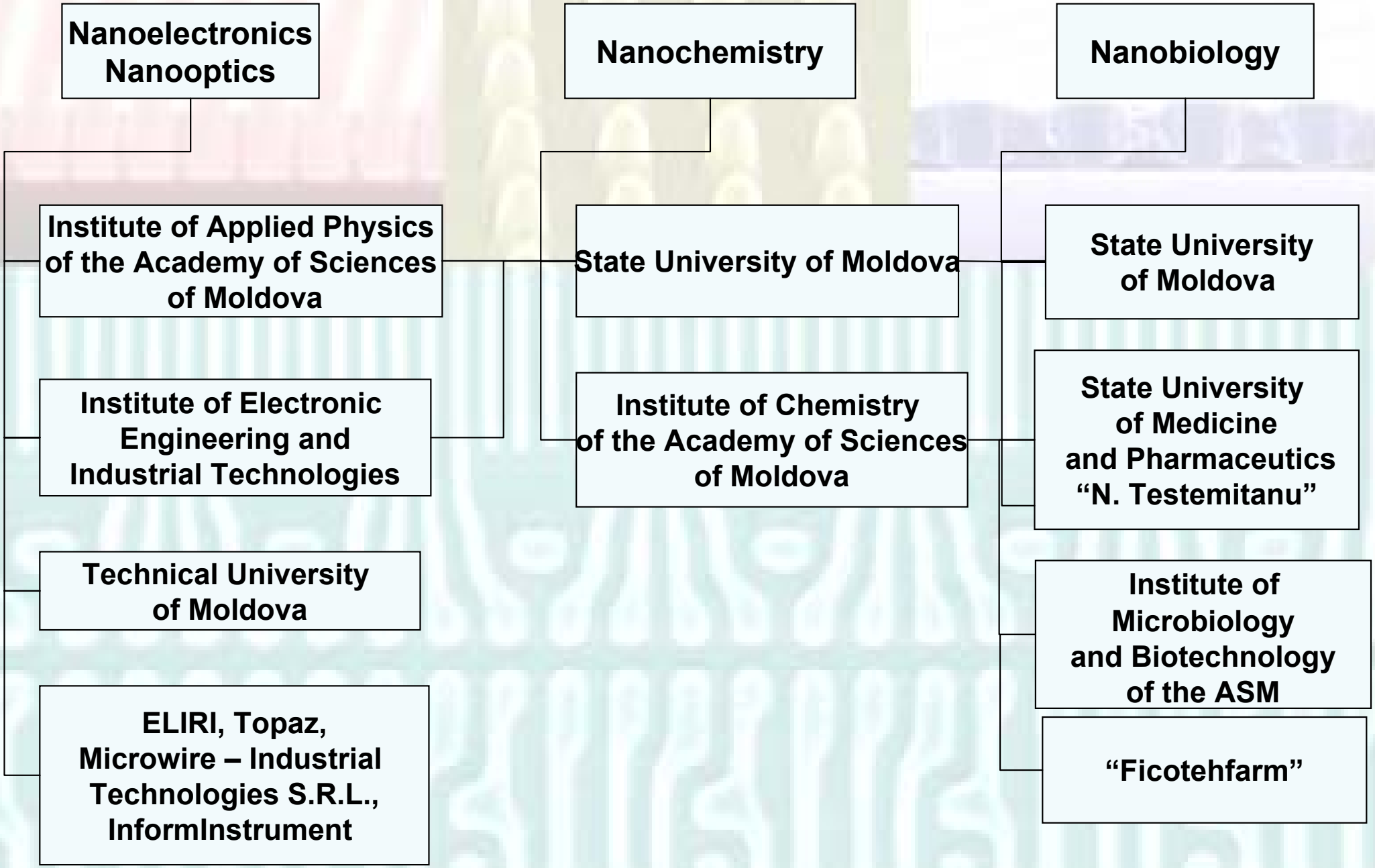
- Professional education of researchers;
- High performance;
- Competitiveness based on scientific criteria, insuring specialization on domains and excellence at the intersection of various fields;
- Growth of innovative capacity through program expansion;
- Management experience;
- Obtaining of management and marketing capacity in research-development.

Integration of science, innovation and education

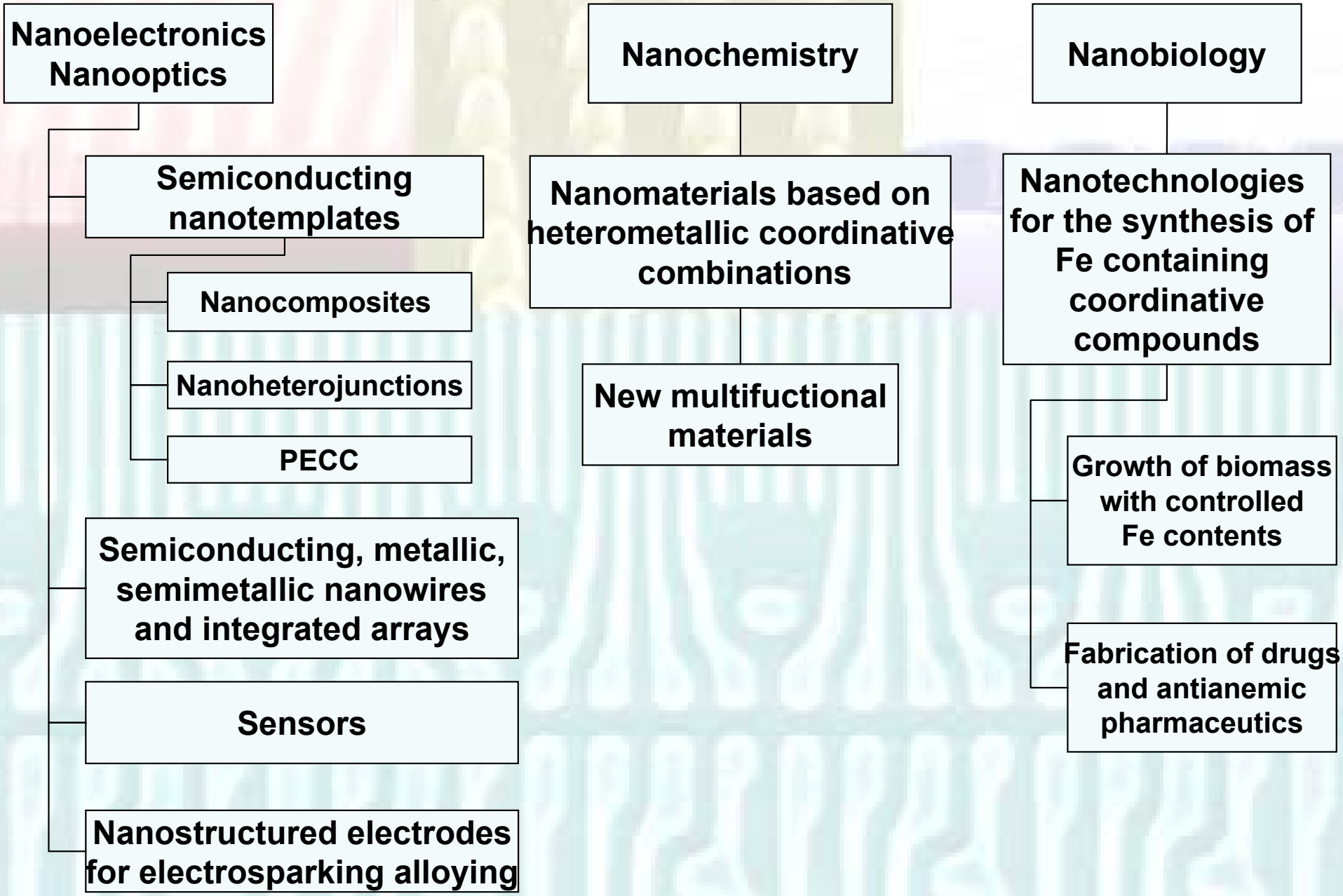


Nanoscience and Nanotechnologies in Moldova: Main players

Nanoscience and nanotechnology in Moldova



Nanoscience and nanotechnology in Moldova

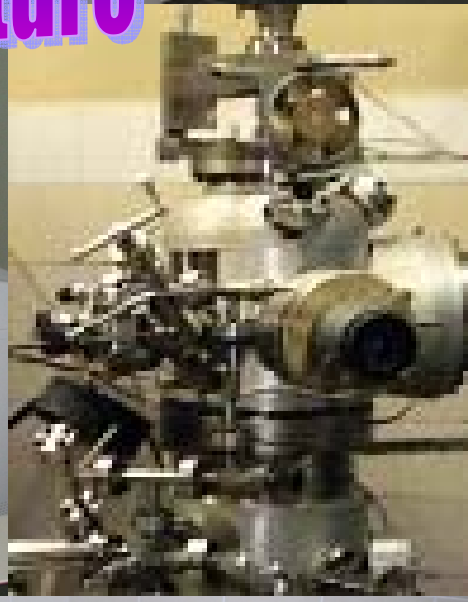


Activities in the field of nanotechnologies in the Republic of Moldova

Nanotechnological infrastructure

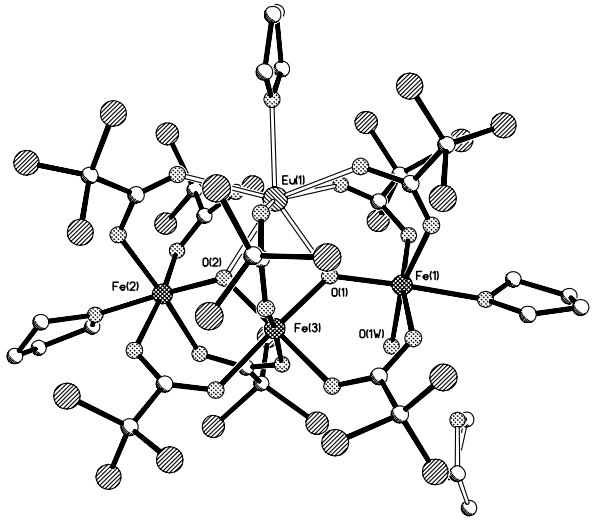




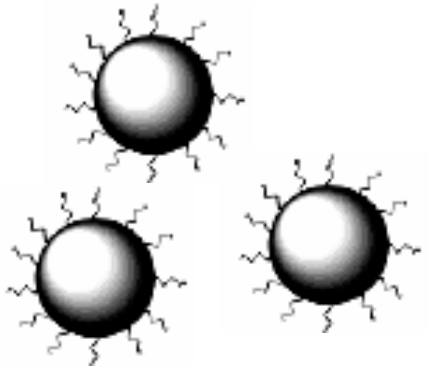
Nanotechnologies in the Republic of Moldova

1. Chemical and electrochemical technologies for growth of clusters, nanocrystals, quantum dots etc.



reflux 200 - 350 C

1, 2 hexadecanediol
RCOOH, RNH_2
solvent



20 nm

2. Technologies for layer deposition, including epitaxy

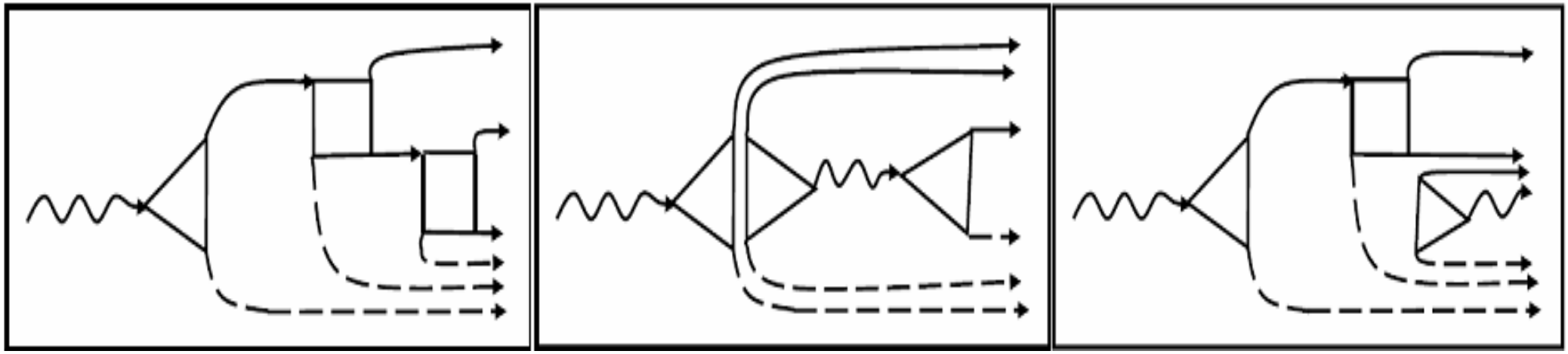
GaN ZnO GaAs InP polymers

3. Methods for the fabrication of nanowires, nano-structures and integrated networks on their basis

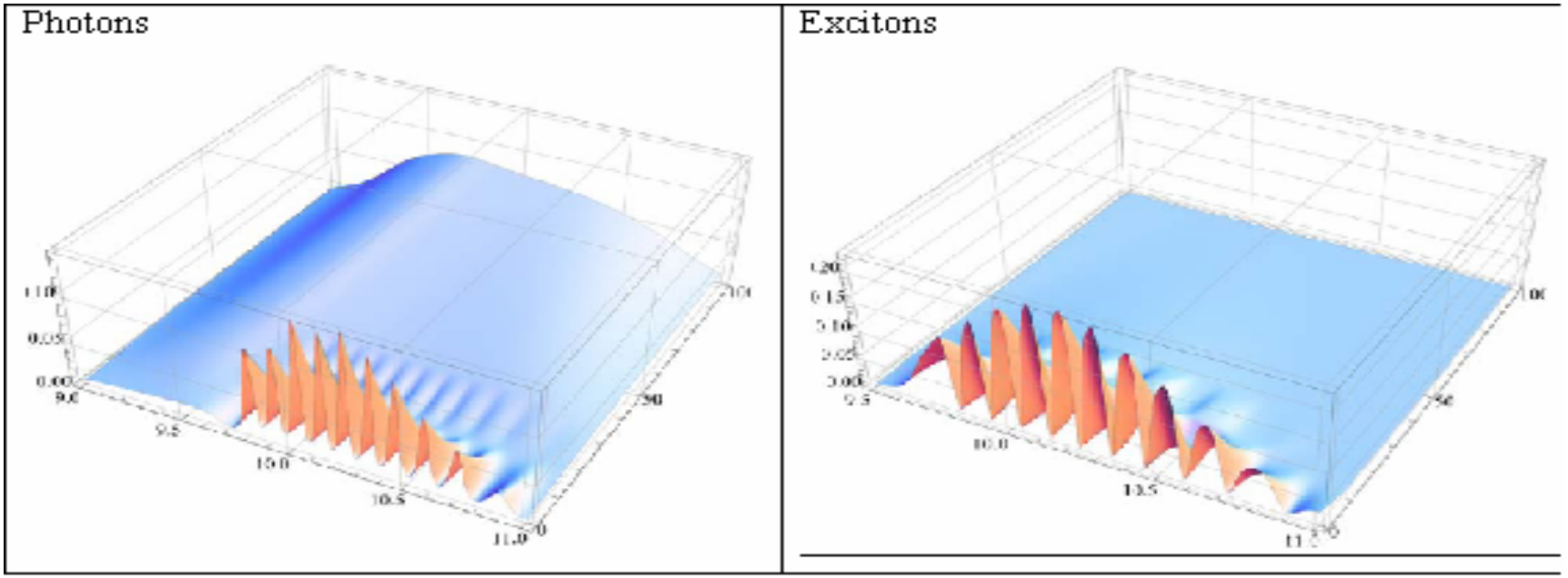
metals semimetals semiconductors nanocompozites

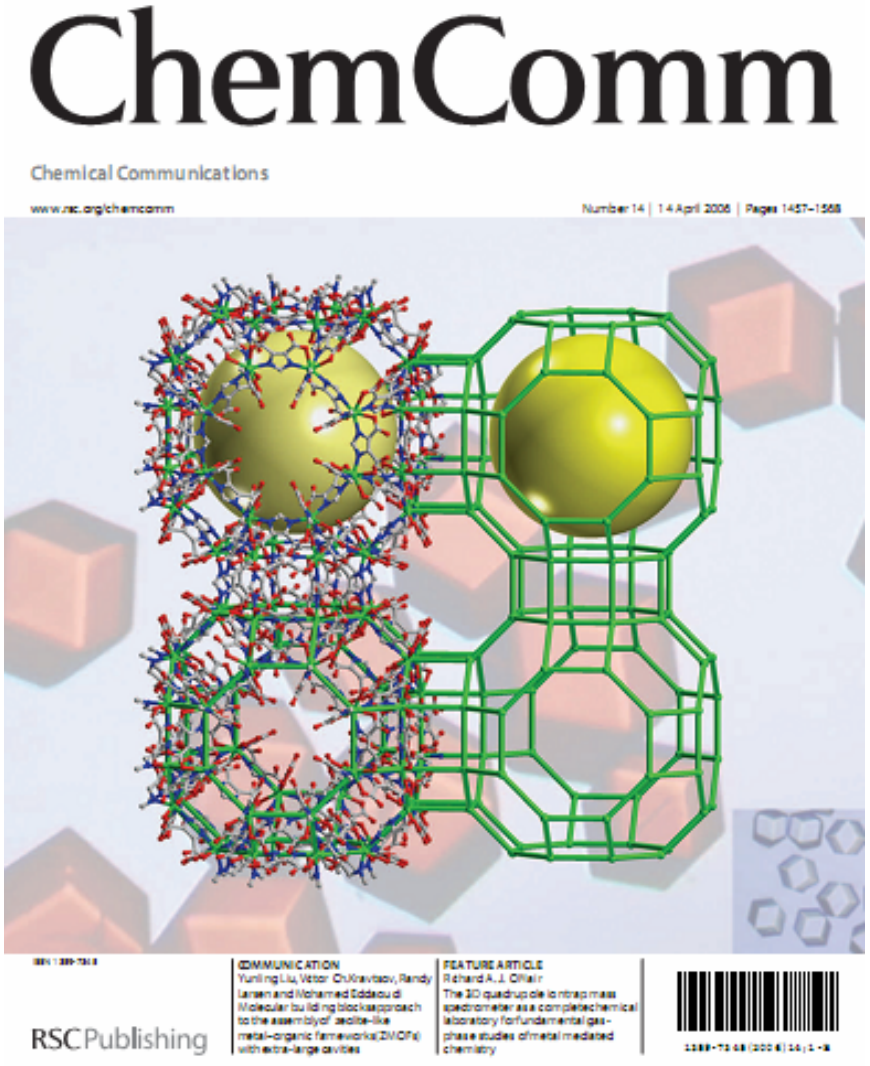
Theoretical support

Multiplication of charged carriers in semiconductor quantum dots



Transmission and reflection of ultrashort laser pulses From thin semiconductor films

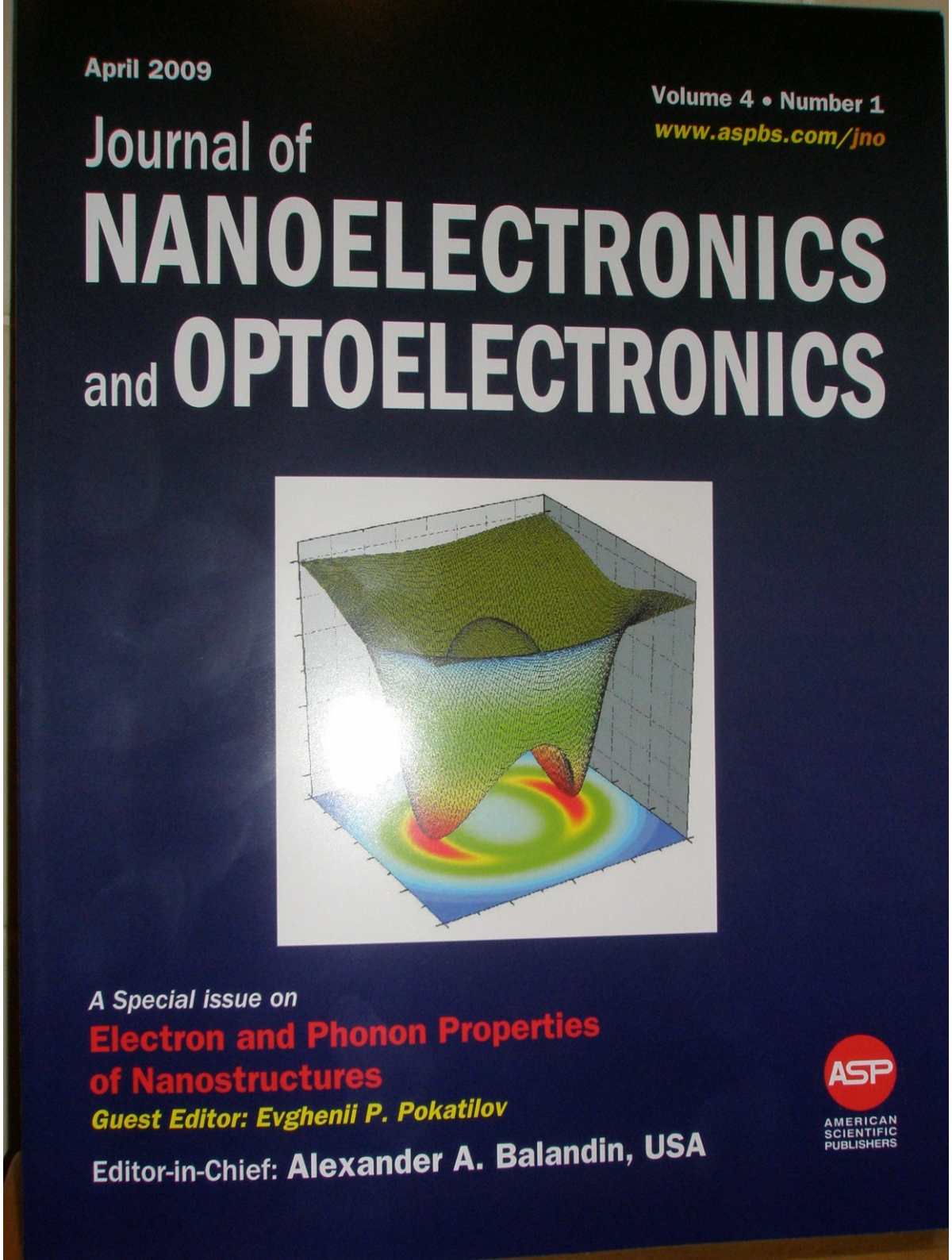




Molecular building blocks approach to the assembly of zeolite-like metal–organic frameworks with large cavities

Titania-Pt

ZnSe-Pt



Guest Editor E.P. Pokatilov
Republic of Moldova

New State Program on Nanotechnologies and Nanomaterials in Moldova

State Program on Nanotechnologies and Nanomaterials

Cluster 1. Novel nanocomposite, nanoporous and ordered nanostructured materials for optoelectronic and photonic applications

1. Development of 2D and 3D metallo-dielectric and metallo-semiconductor structures for electronic and photonic applications (Ion Tiginyanu).

2. Elaboration of nanocomposites based on organic-inorganic materials for luminescent and diffraction devices (Andrei Andriesh).

3. New metalorganic nanoporous absorbent materials (Bourosh Paulina).

4. Synthesis and characterization of thermal properties of new polymeric nanocomposite materials with high thermal stability (Ion Dranca).

State Program on Nanotechnologies and Nanomaterials

Cluster 2. Novel materials for energy conversion and storage

1. **Elaboration of nanostructured composites of lead and bismuth chalcogenides for energy conversion systems (Andrei Nicorici).**

2. **Semiconductor colloidal nanocrystals for applications in infra-red photoelectrical devices (Leonid Culiuc).**

3. **New nanometric multi-layer semiconductor structures for applications in technologies of energy conversion and storage (Igor Evtodiev).**

State Program on Nanotechnologies and Nanomaterials

Cluster 3. Technologies of thin films and multi-layer structures for applications in machine building and electronics

1. **Electrosparking technology of discrete chemo-thermal treatment of surfaces for anticorrosive protection of machine parts (Alexandru Balanici).**

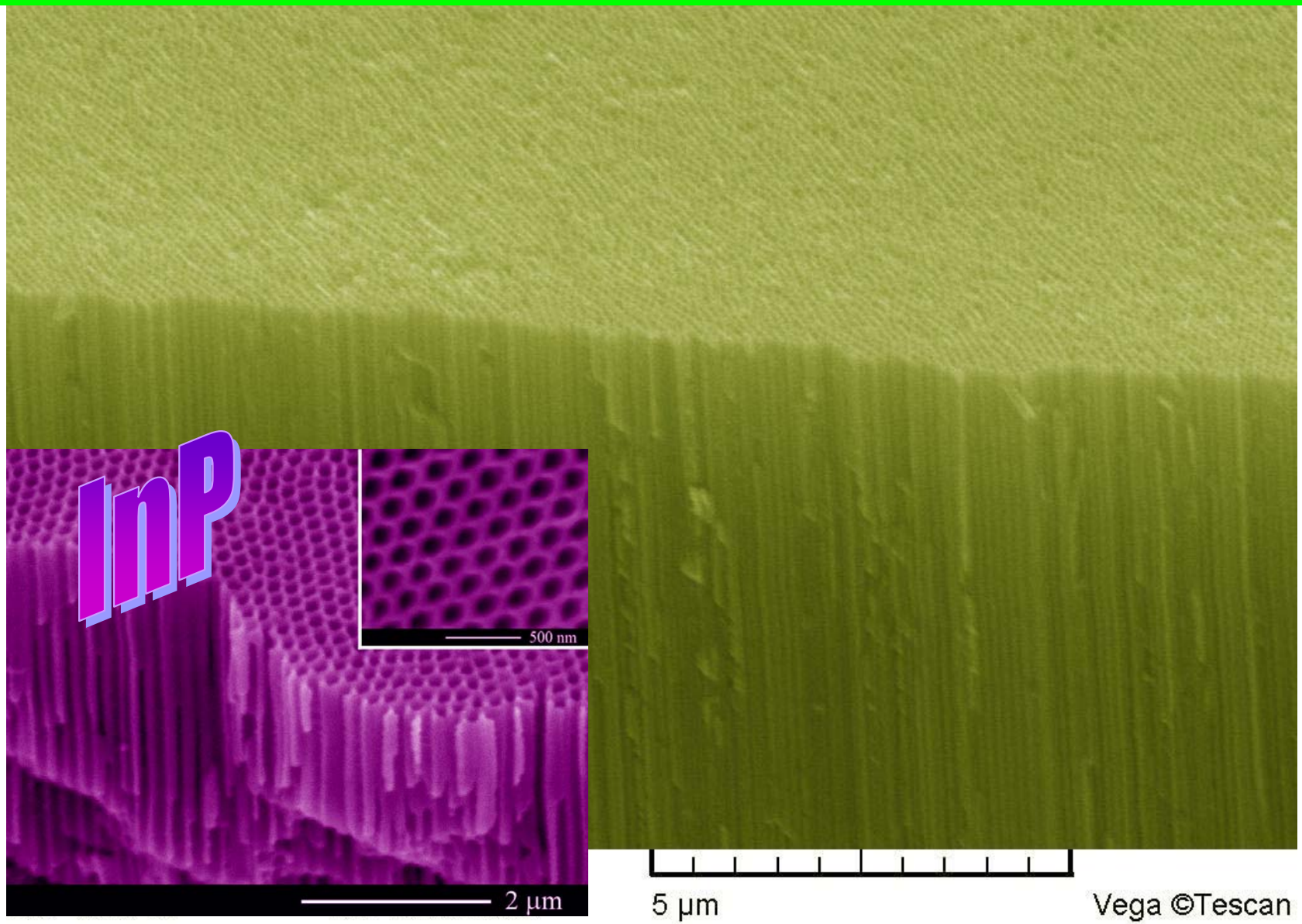
2. **Electrodeposition of multi-layer nanocomposites and study of corrosive, tribological and magnetic properties for applications (Alexandru Dicusar).**

3. **Cost-effective technologies for growth of nanostructured ZnO films for photonic and nanoelectronic applications (Emil Rusu).**

4. **Elaboration of GaInP/GaAs(InP) nanostructured films by Vapor Phase Epitaxy for electronic applications (Leonid Gorceac).**

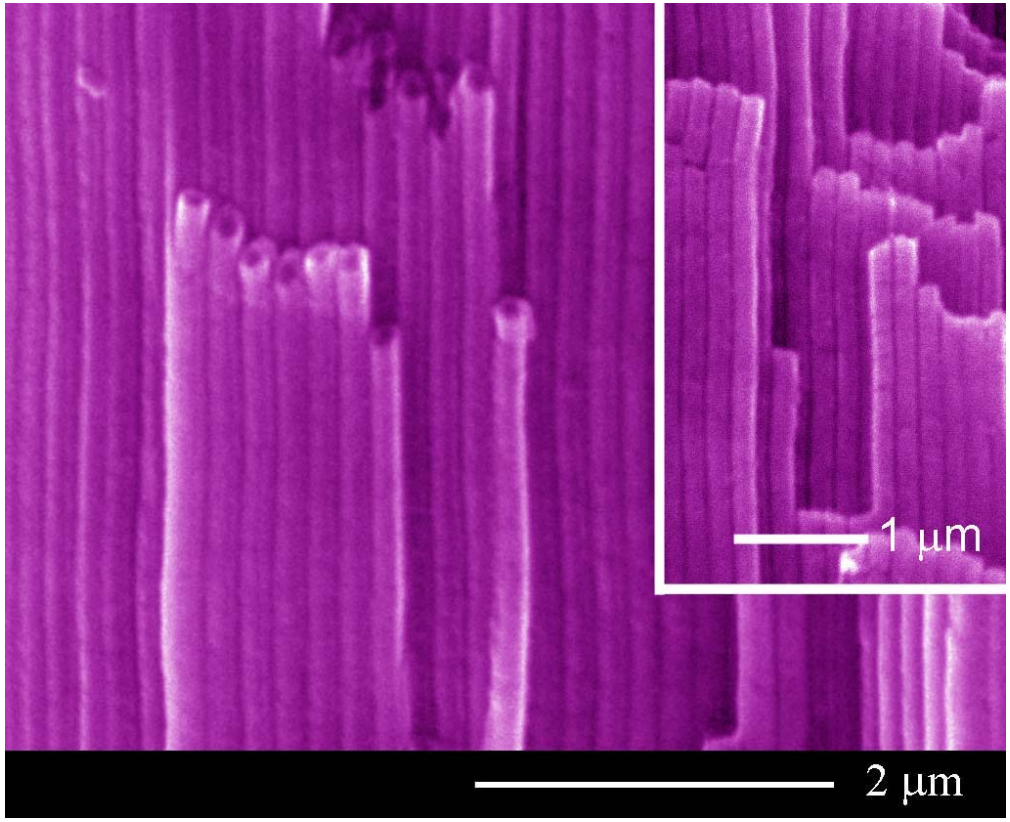
Achievements in the field of nanotechnologies in the Republic of Moldova

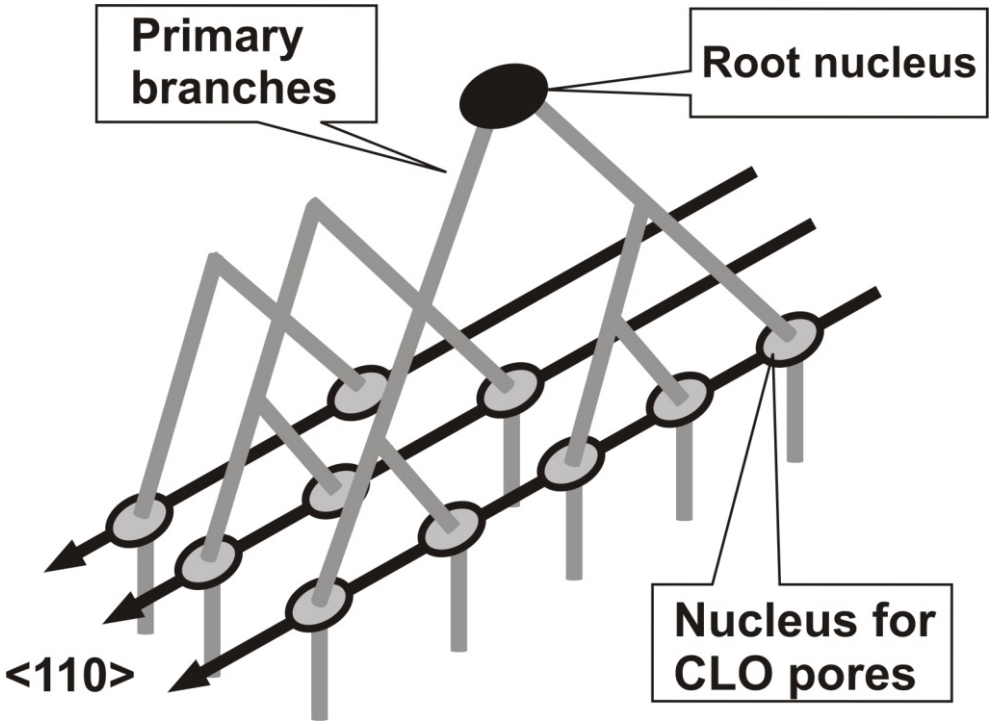
Nanotemplates for nanofabrication

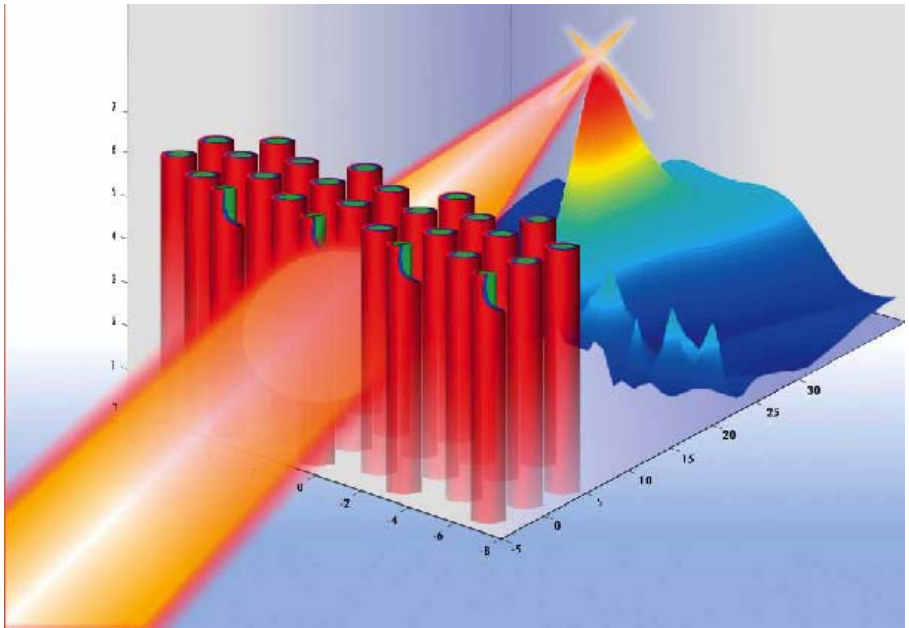


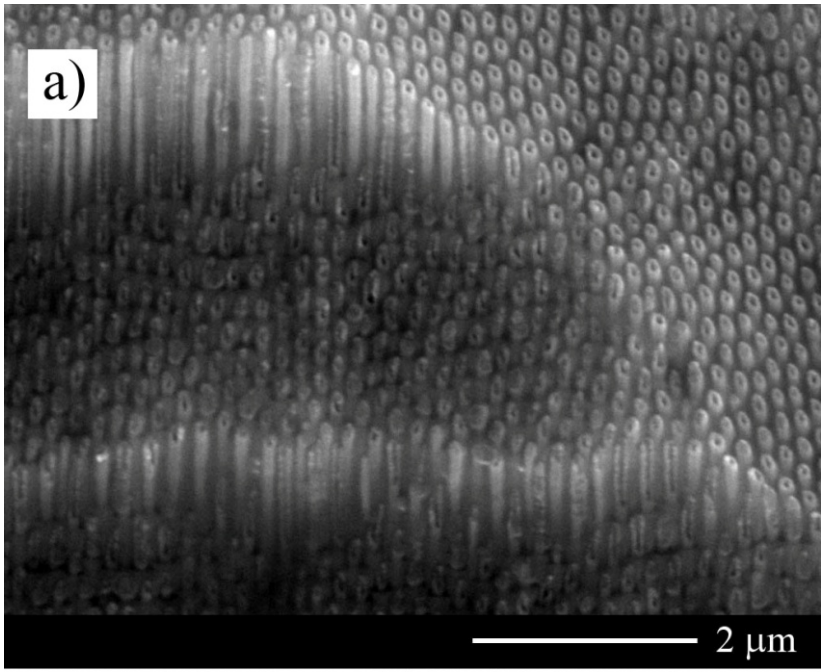
Electrochemical & Solid-State Letters, Vol. 10, pp. D127-D129 (2007);

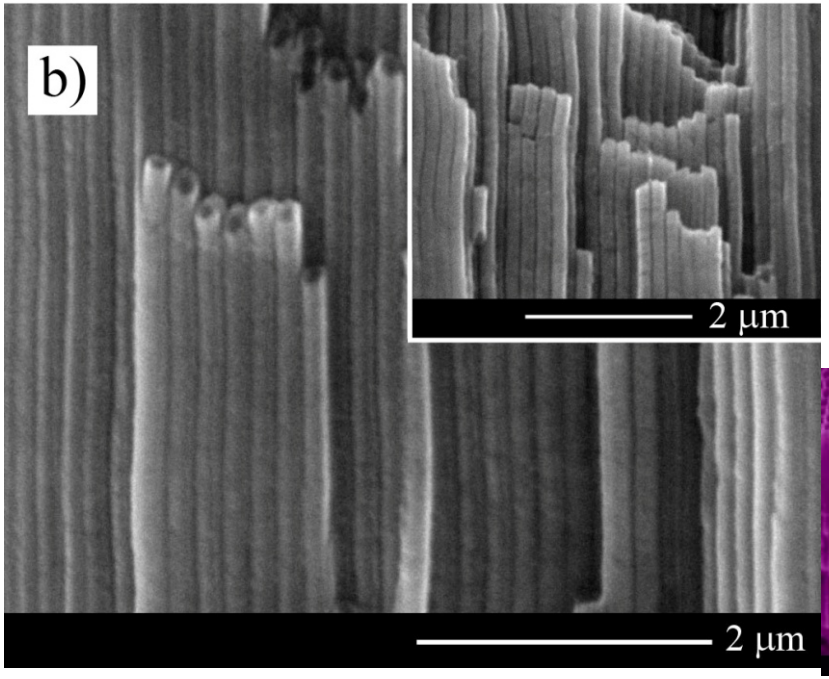
Physica Status Solidi (RRL) – Rapid Research Letters, Vol. 1, issue 3, pp. 98-100 (2007)

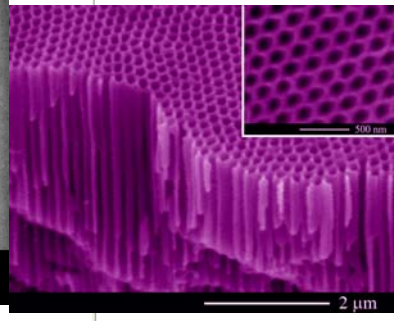

1 μm
2 μm


Primary branches
Root nucleus
<110>
Nucleus for CLO pores







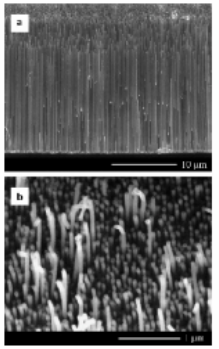


TECHNOLOGY UPDATE

Jun 23, 2008

Salty water puts metal nanotubes in order

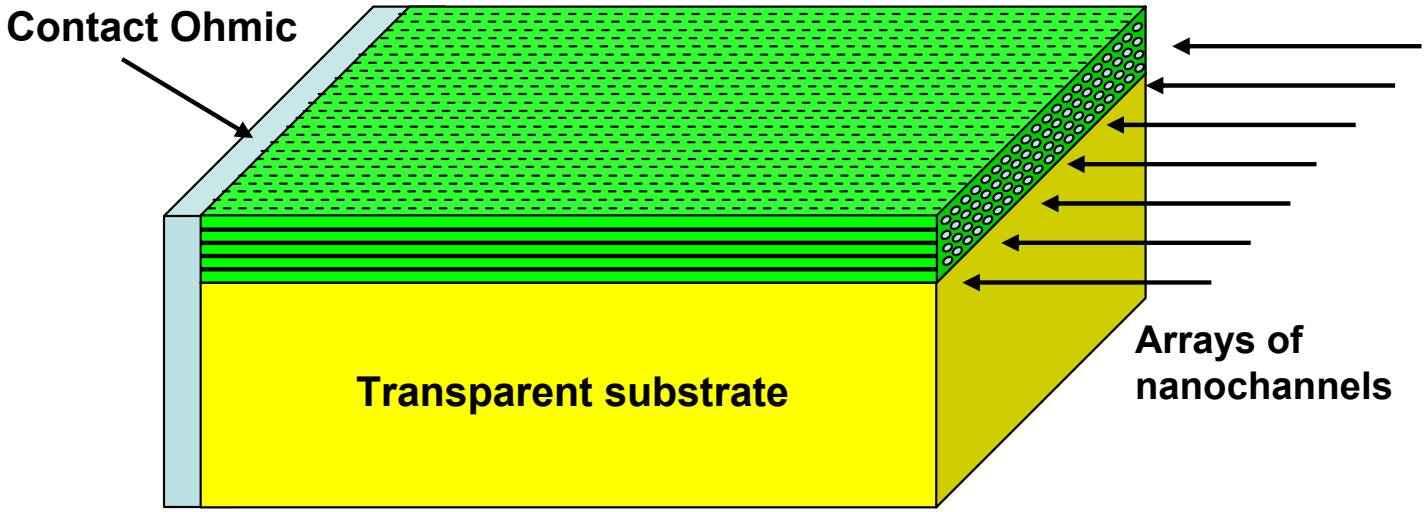
A new, simple technique to produce ordered arrays of metal nanotubes has been developed by scientists in Moldova. The method works by electroplating in conductive nanotemplates routinely fabricated by anodic etching of semiconductor substrates in salty water. The result could be important for making plasmonic devices, photonic crystals, catalysts for energy conversion and chemical and biological sensors.

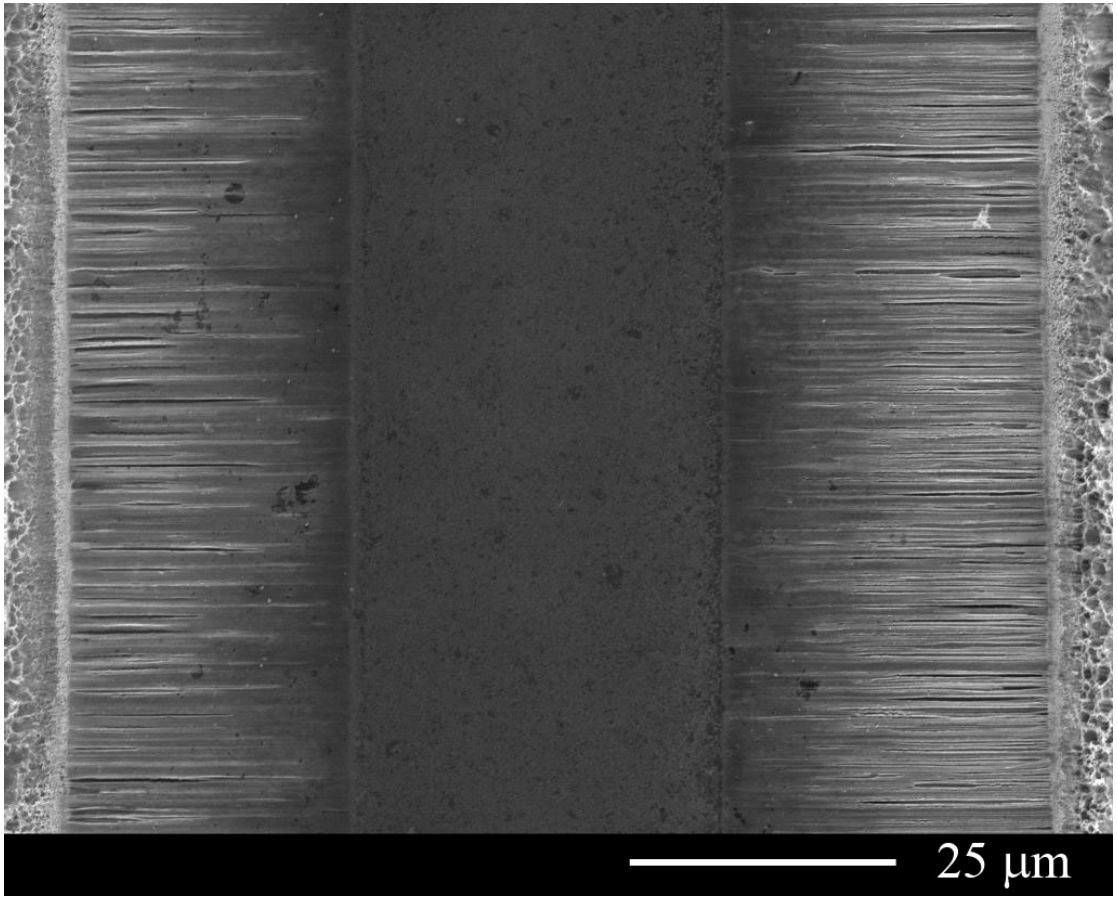


Ion Tiginyanu and colleagues from the National Center for Materials Study and Testing have developed a cost-effective and environmentally friendly nanofabrication approach for making semiconductor nanotemplates.

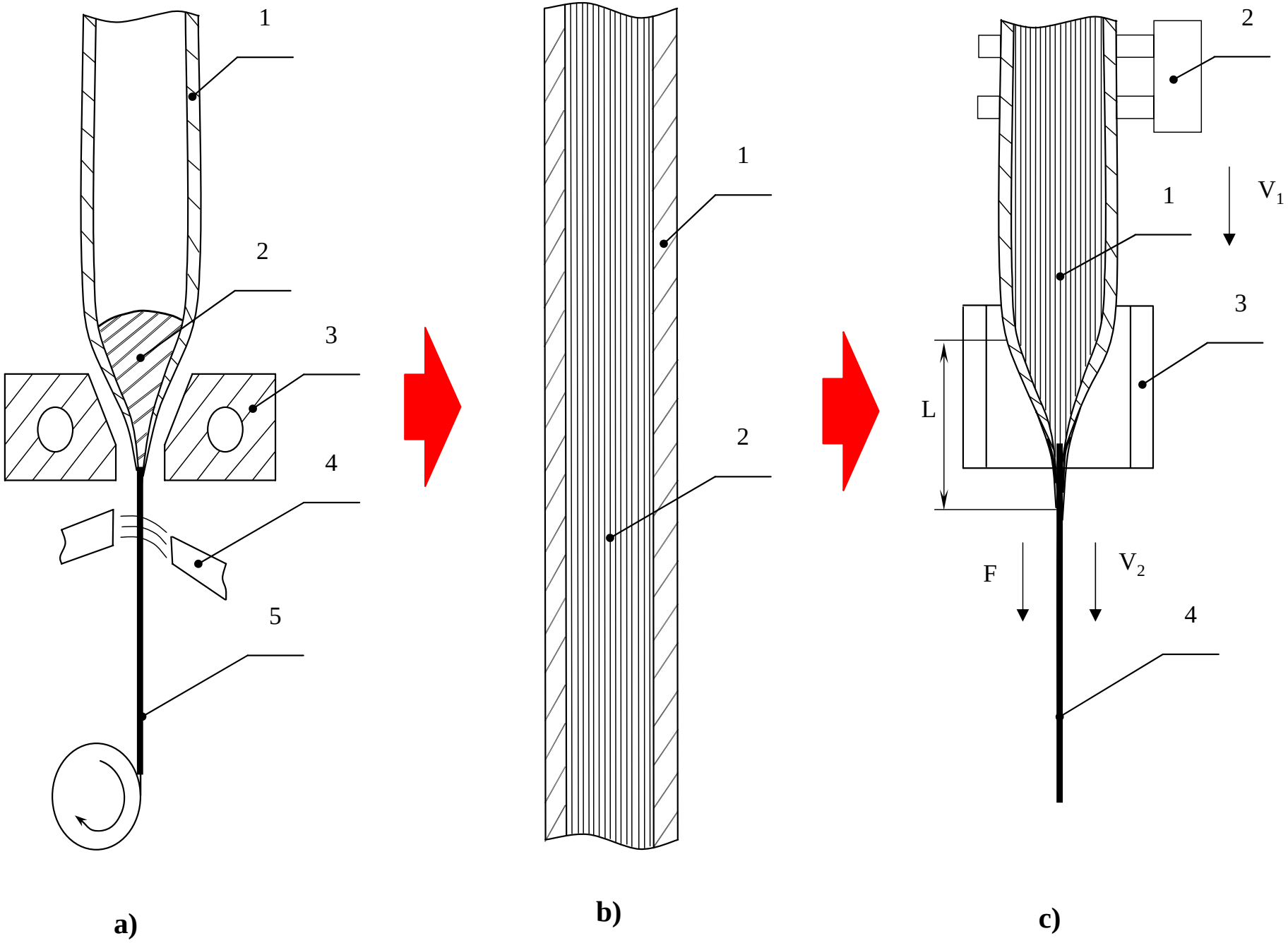
The researchers showed that anodic etching of crystalline substrates of indium phosphide - a semiconductor compound used in modern electronics - in a neutral electrolyte based on an aqueous solution of sodium chloride leads to spatial nanostructuring of the material. In particular, it leads to the growth of self-organized ordered two-dimensional arrays of pores with transverse dimensions as low as 70±nm. "In fact, we have succeeded in producing high-quality nanotemplates by anodic etching of indium phosphide substrates in salty water from the Black Sea," Tiginyanu told *nanotechweb.org*.

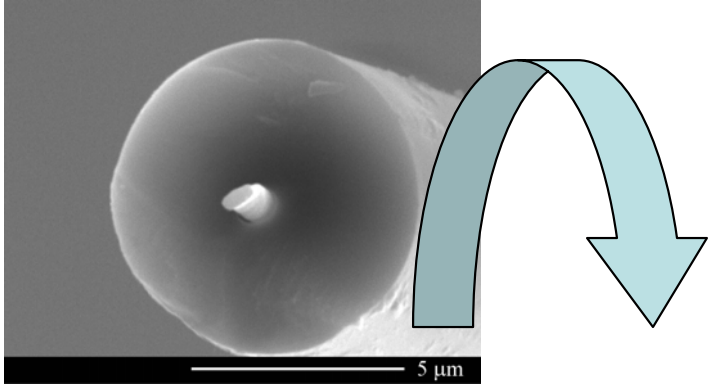
Currently, two types of nanotemplates are widely used in nanofabrication: porous aluminium oxide and etched ion track membranes based either on inorganic materials or organic polymers. However, both of these materials have high resistivity and therefore only play a passive role in nanofabrication processes. "The great advantage of the semiconductor nanotemplates we used is their electrical conductivity, which can effectively be controlled during fabrication using light or applied electric fields, for example," said Tiginyanu.


Contact Ohmic
Transparent substrate
Arrays of
nanochannels

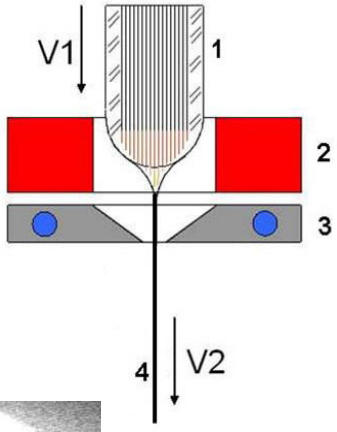

25 µm

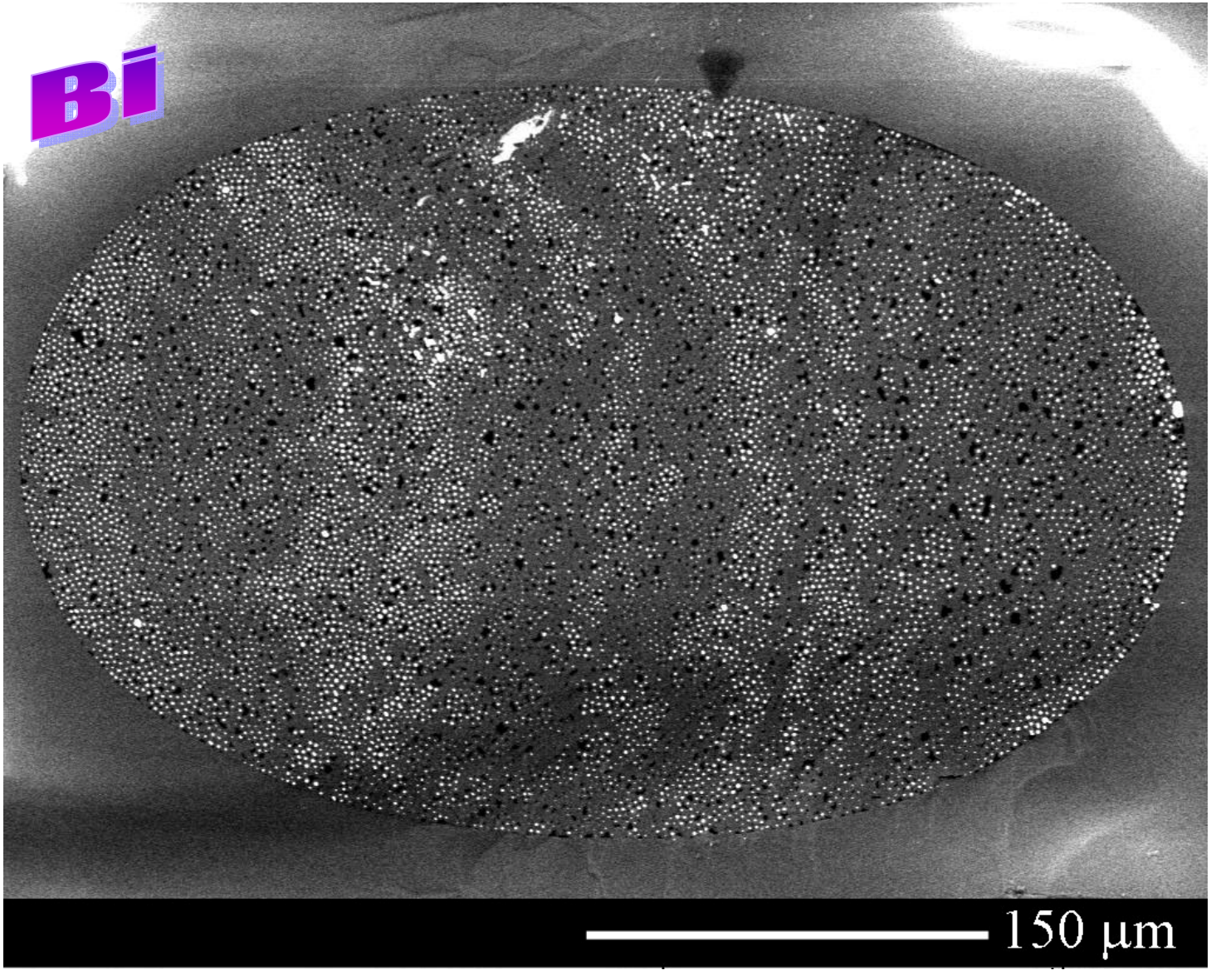
Arrays of nanowires in glass envelopes

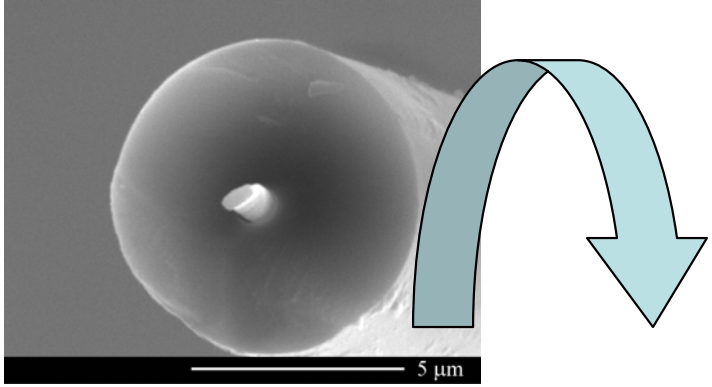

1
2
3
4
5
a)
1
2
b)
2
1
V1
3
L
F
V2
4
c)



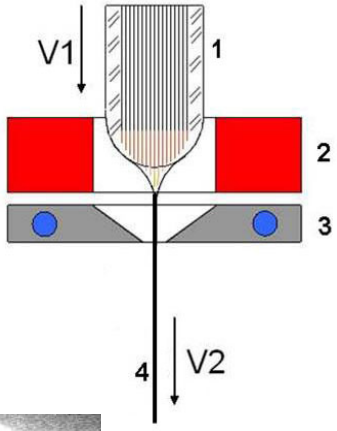
Micro-cables consisting of up to 600,000 nanowires in glass envelope

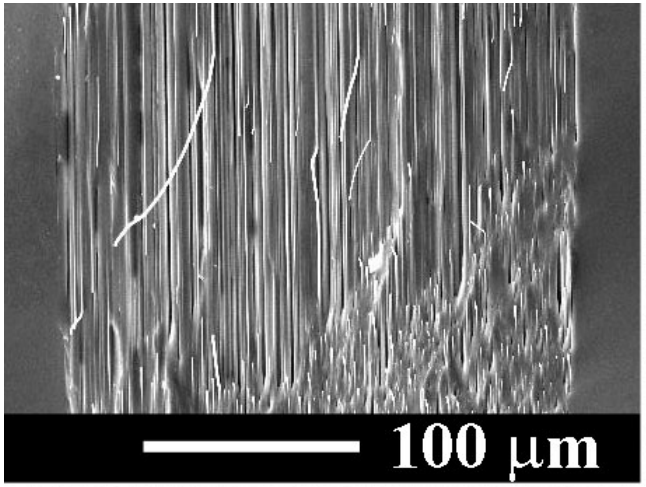


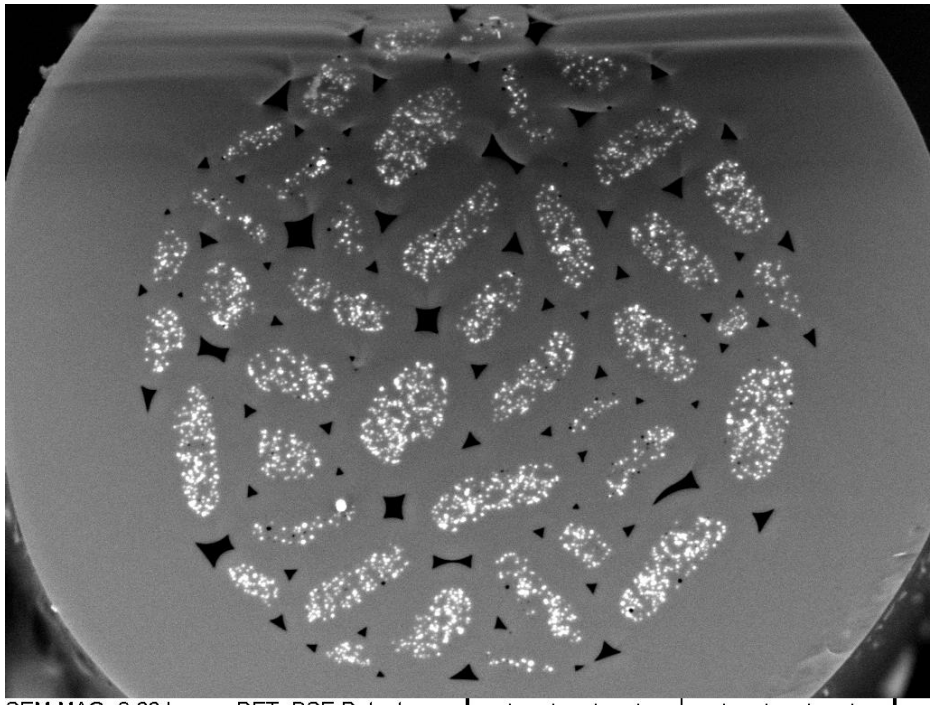


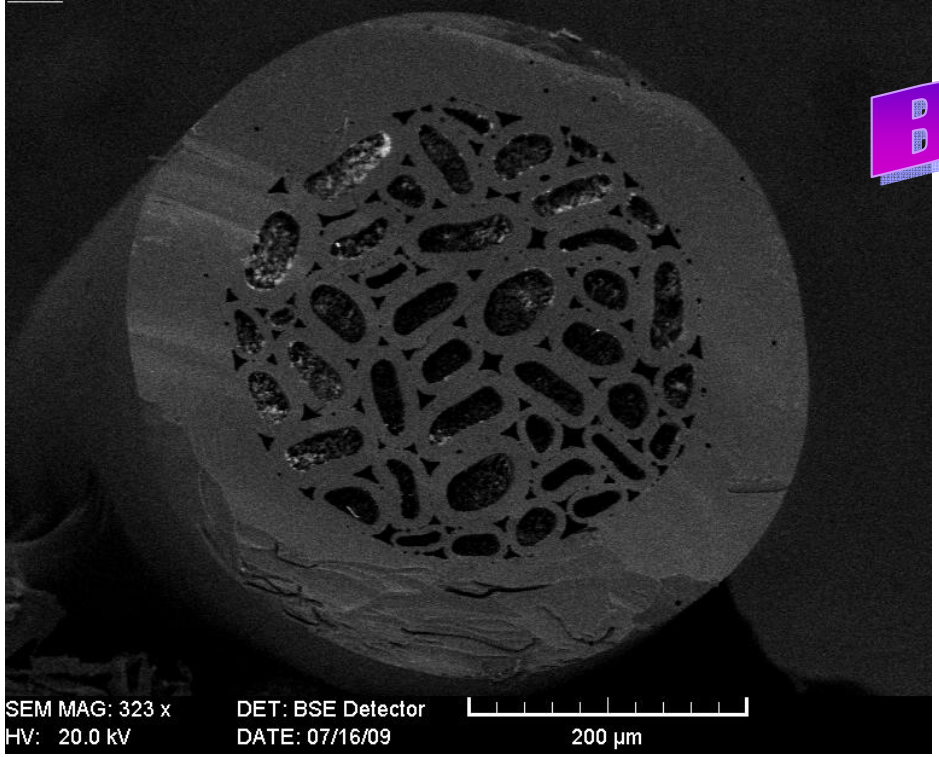


Micro-cables consisting of up to 600,000 nanowires in glass envelope






SEM MAG: 2.66 kx
HV: 20.0 kV
DET: BSE Detector
DATE: 07/11/09
50 µm
Vega ©Tescan
UTM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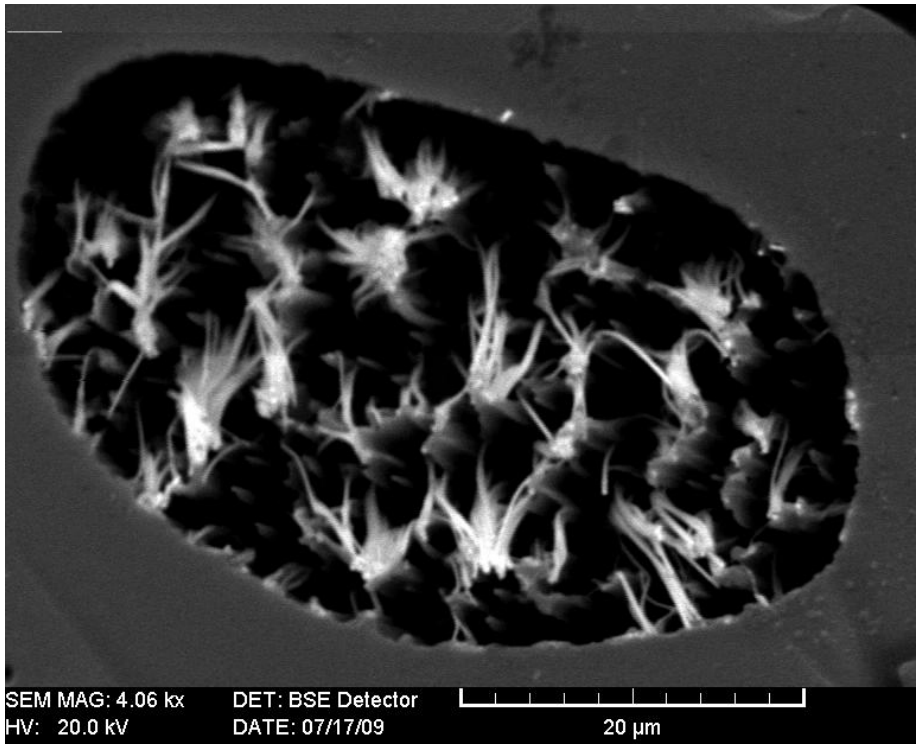
HV: 20.0 kV
DET: BSE Detector
DATE: 07/16/09
200 µm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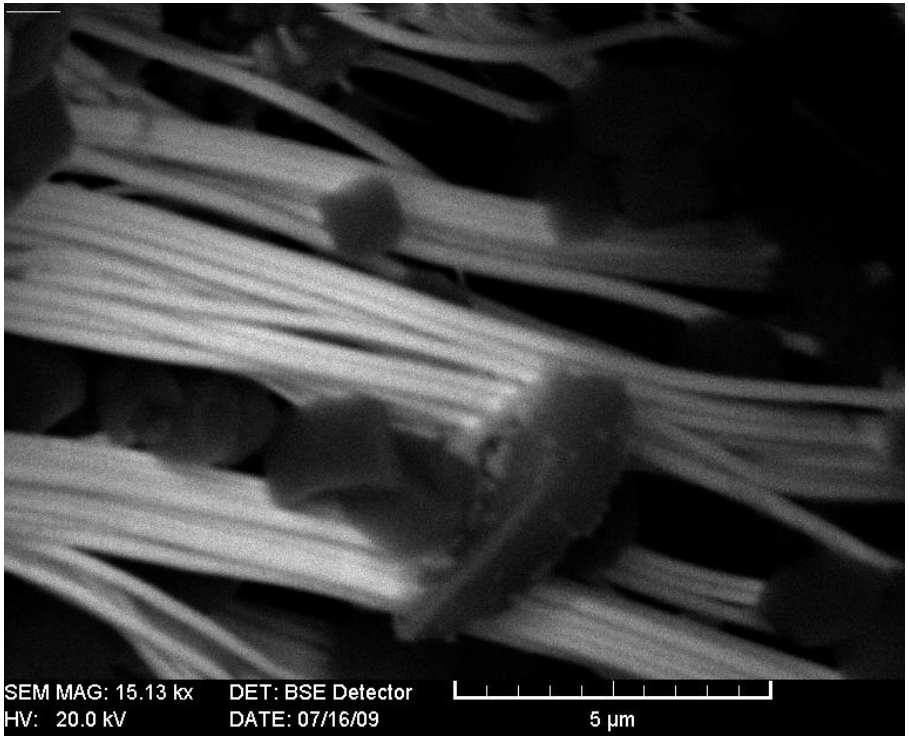
20 µm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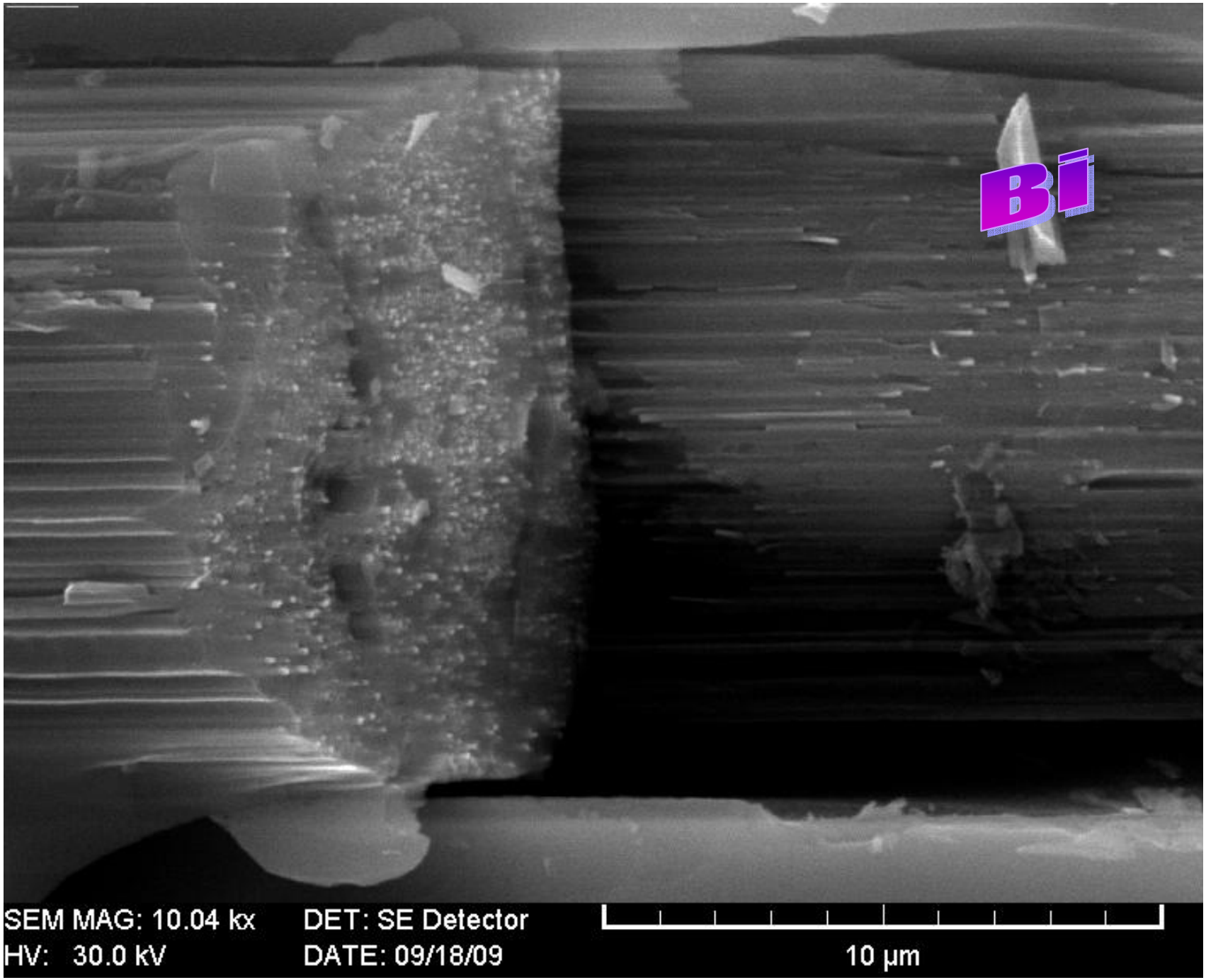
DATE: 07/16/09
5 µm


Bi
SEM MAG: 10.04 kx
HV: 30.0 kV
DET: SE Detector
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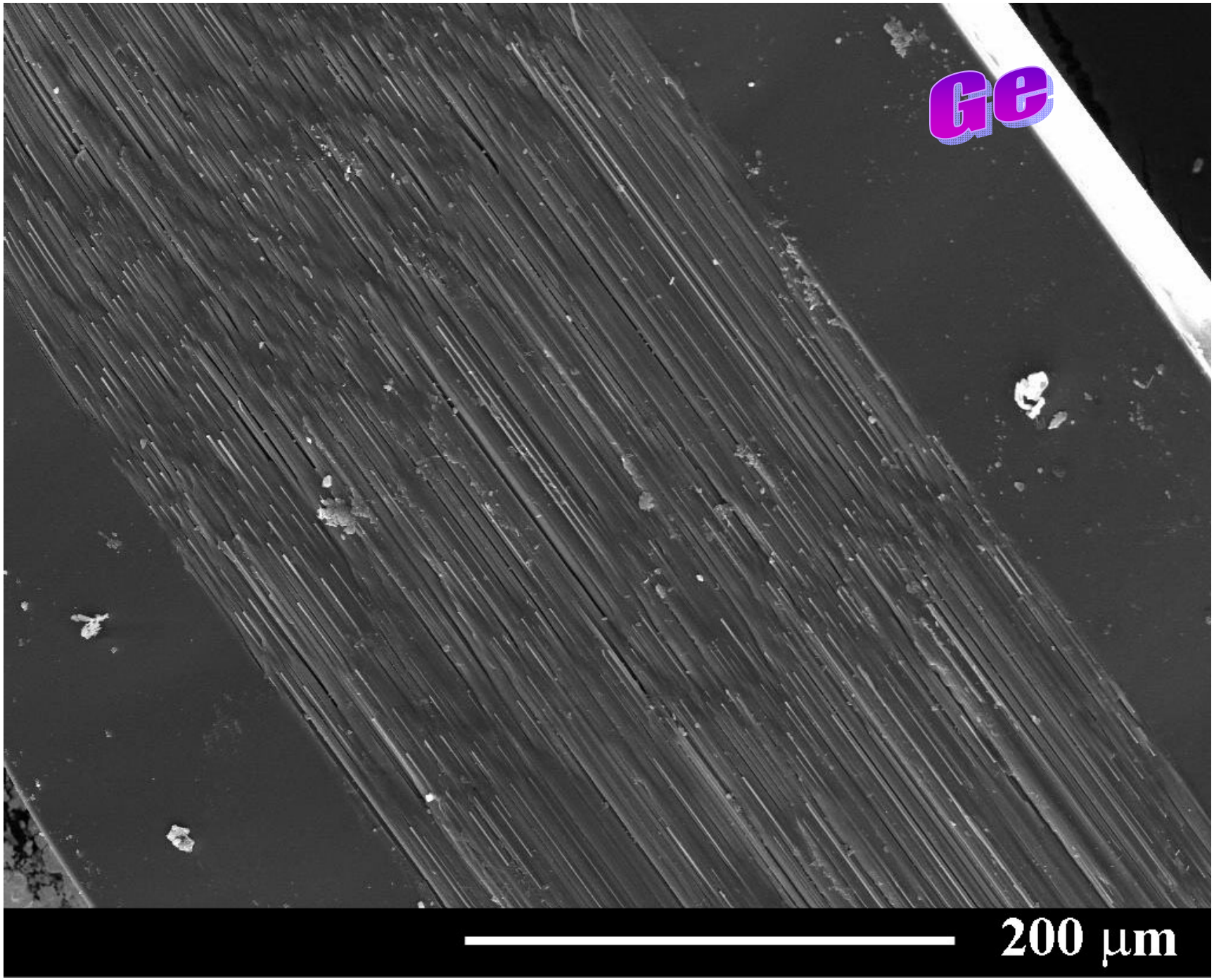
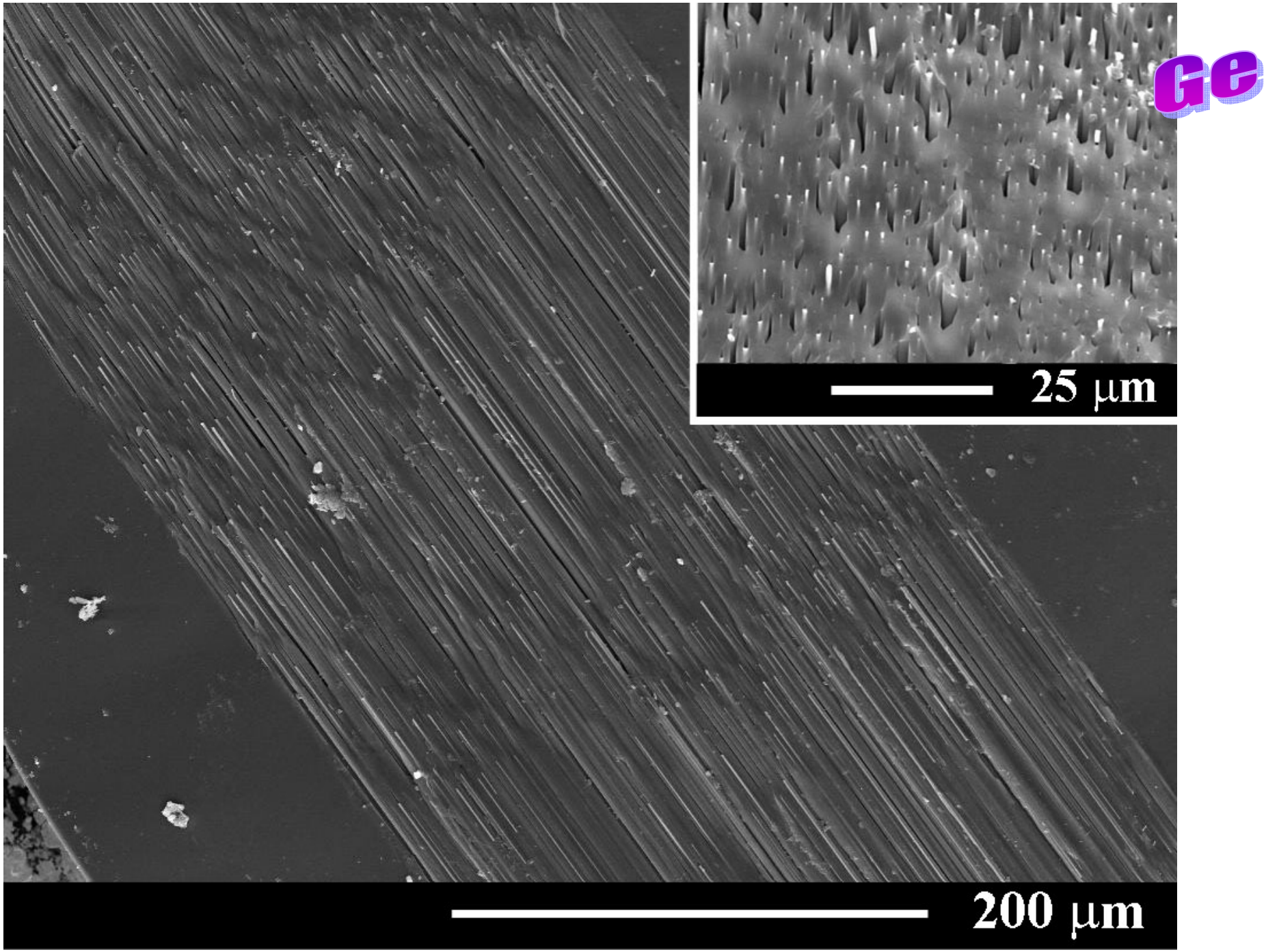
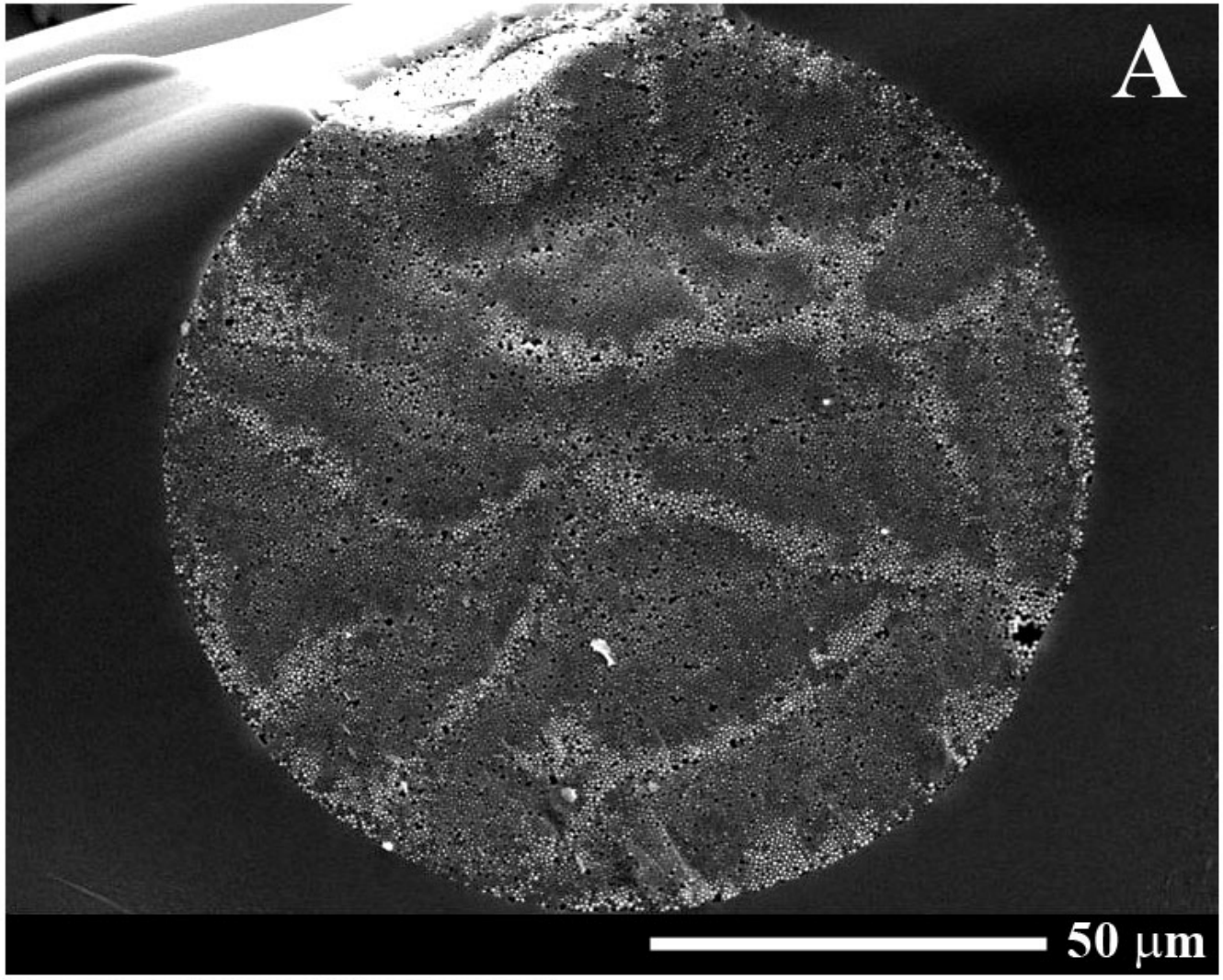
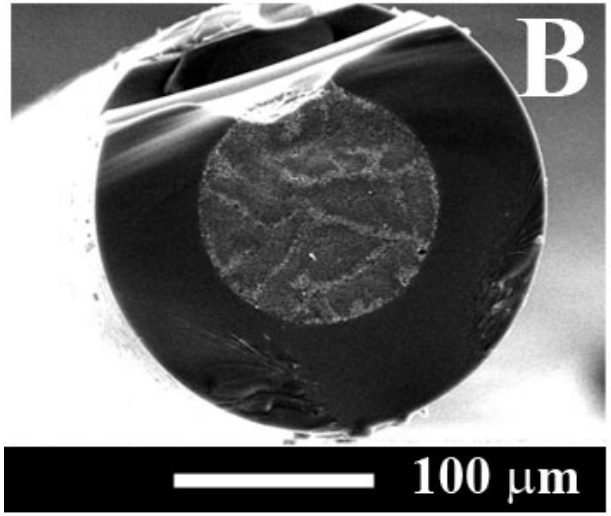
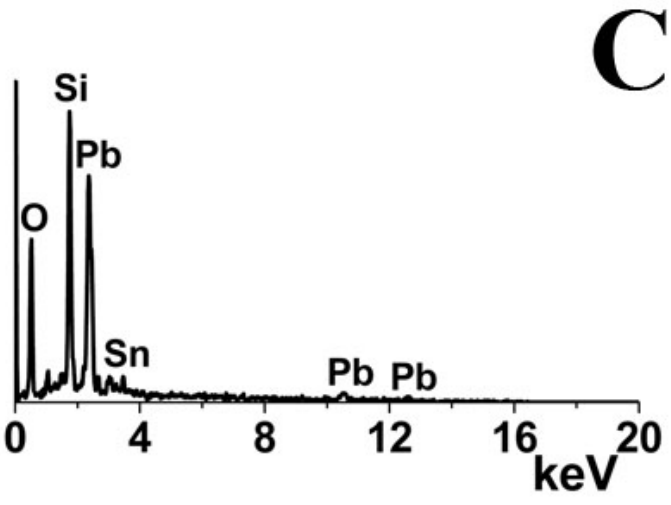
10 µm


Ge
200 μm


Ge
25 μm
200 μm

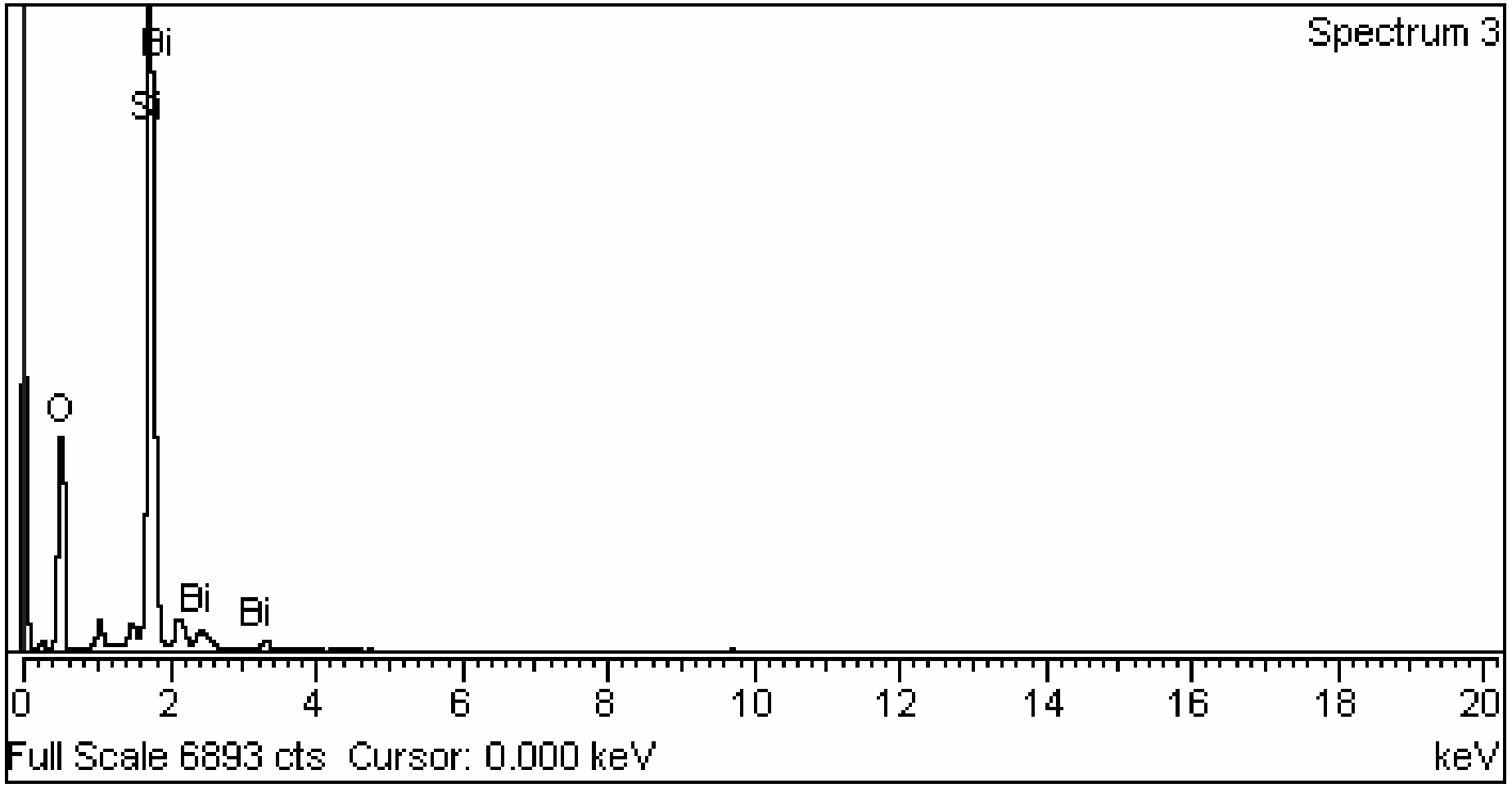


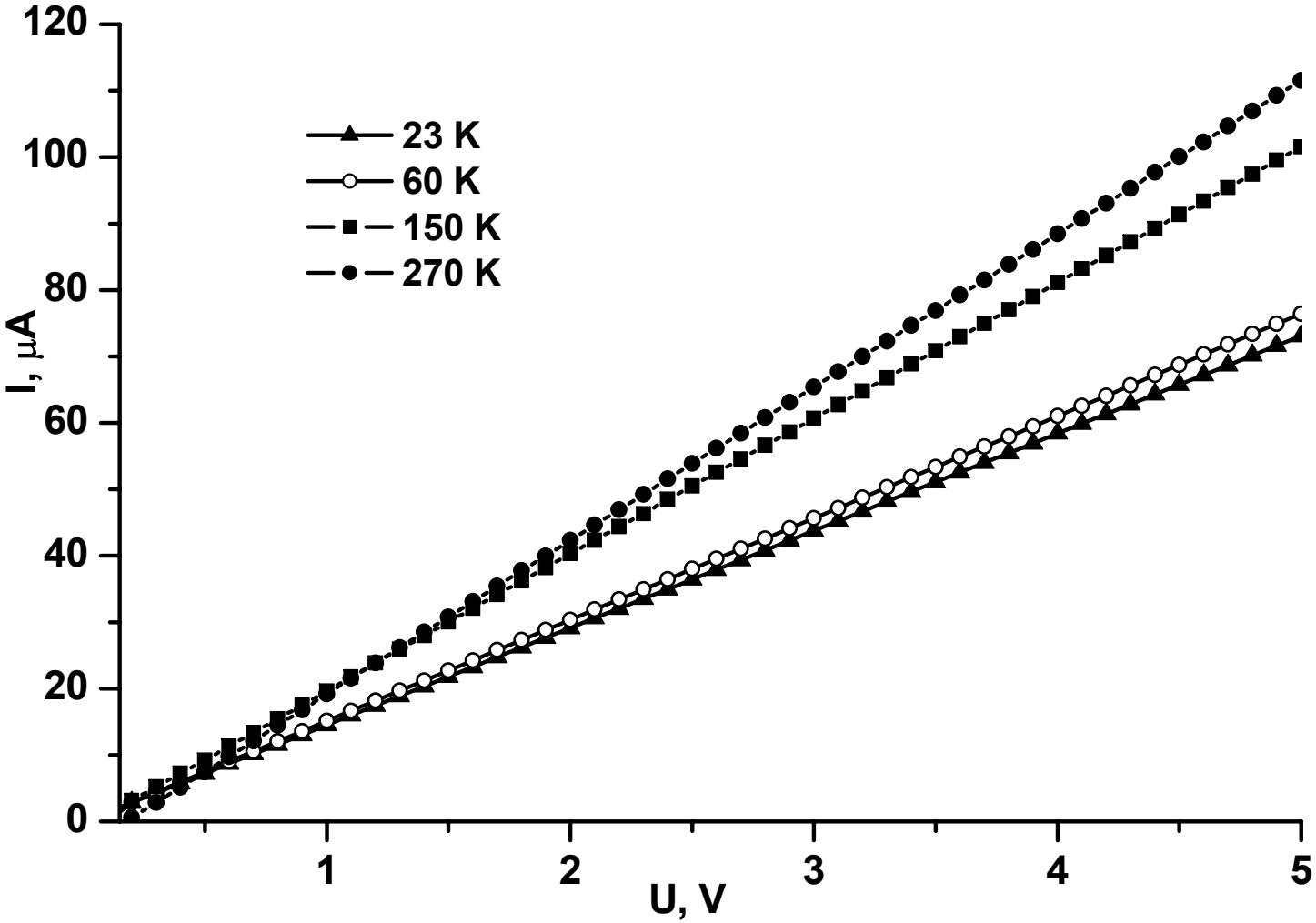




Pb/Sn nanowires

EDX analysis of chemical composition



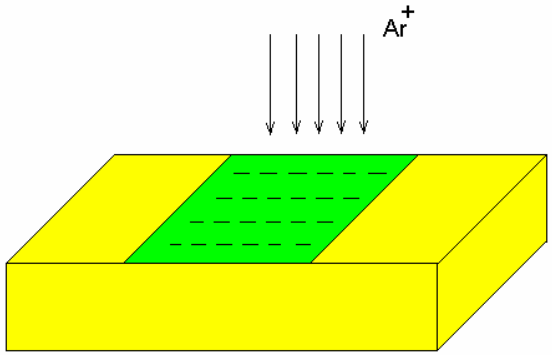


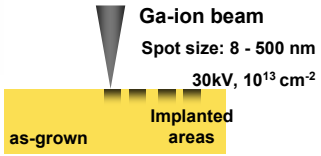
Volt-ampere characteristics at different temperatures of Ga/In electrical contacts to arrays of Bi nanowires in glass envelope.

National Center for Materials Study and Testing

Surface Charge Lithography

1. Direct "writing" of the negative charge by focused ion beam (FIB)





Ion beam treatment

- 2-keV-Ar ions at the dose 3 x 10^{12} cm^{-2}
- 30-keV Ga ions at the dose 6.6 x 10^{12} cm^{-2}, beam current of 150 pA (penetration 14 nm), pixel format (1 pixel 30 nm)

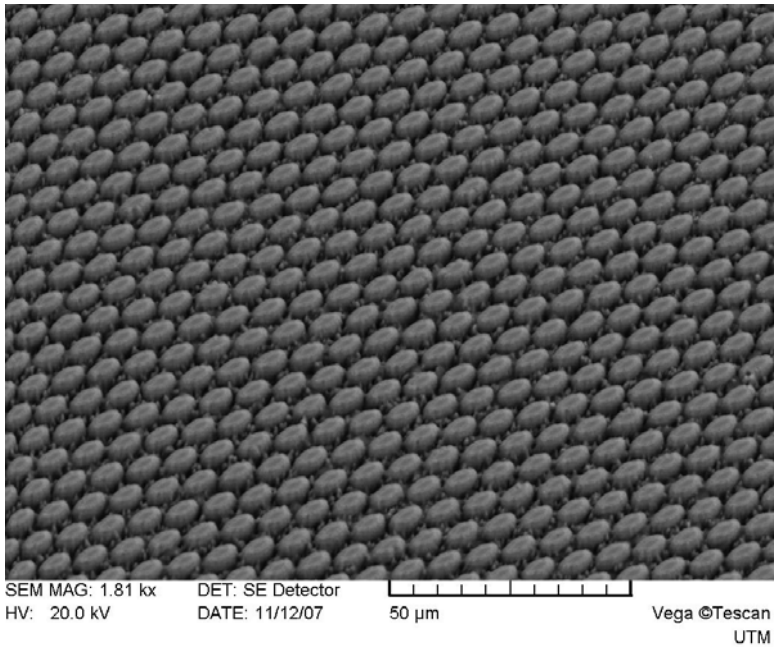
2. Photoelectrochemical etching of the FIB-treated structures

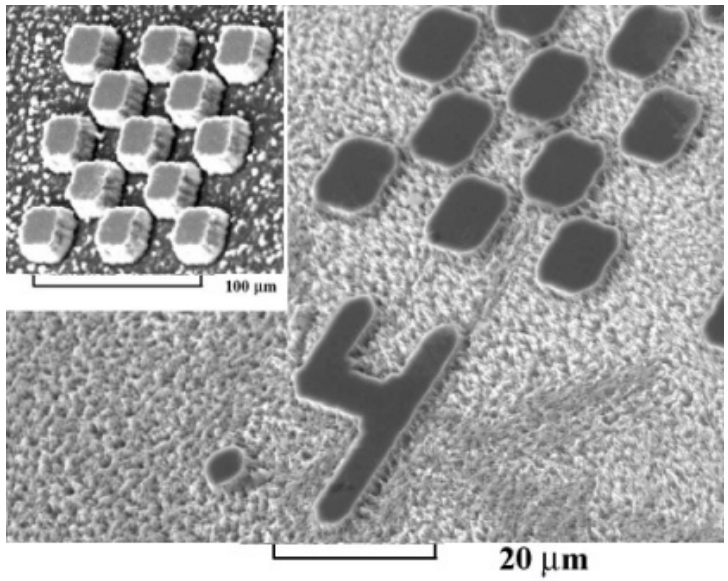
PEC etching was carried out in stirred 0.1 mol aqueous solution of KOH under in-situ ultraviolet (UV) illumination provided by focusing the radiation of a 350 W Hg lamp to a spot of about 5 mm in diameter on the GaN surface exposed to electrolyte.

In most cases we used MOCVD-grown n-GaN layers with electron concentration of 1.7 x 10^{17} cm^{-3}, the density of dislocations was in the range of 10^{9}-10^{10} cm^{-2}.

Surface Charge Lithography

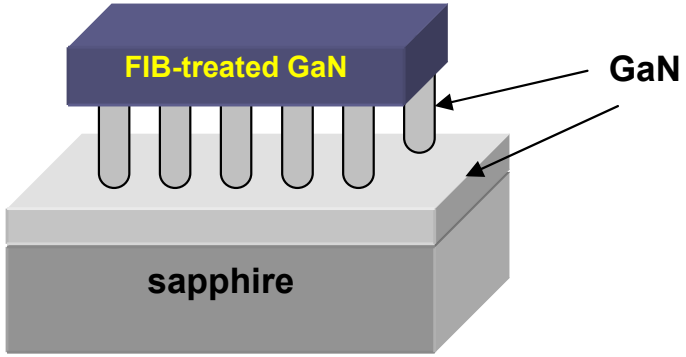
Gold Medal, Pittsburg, 2005



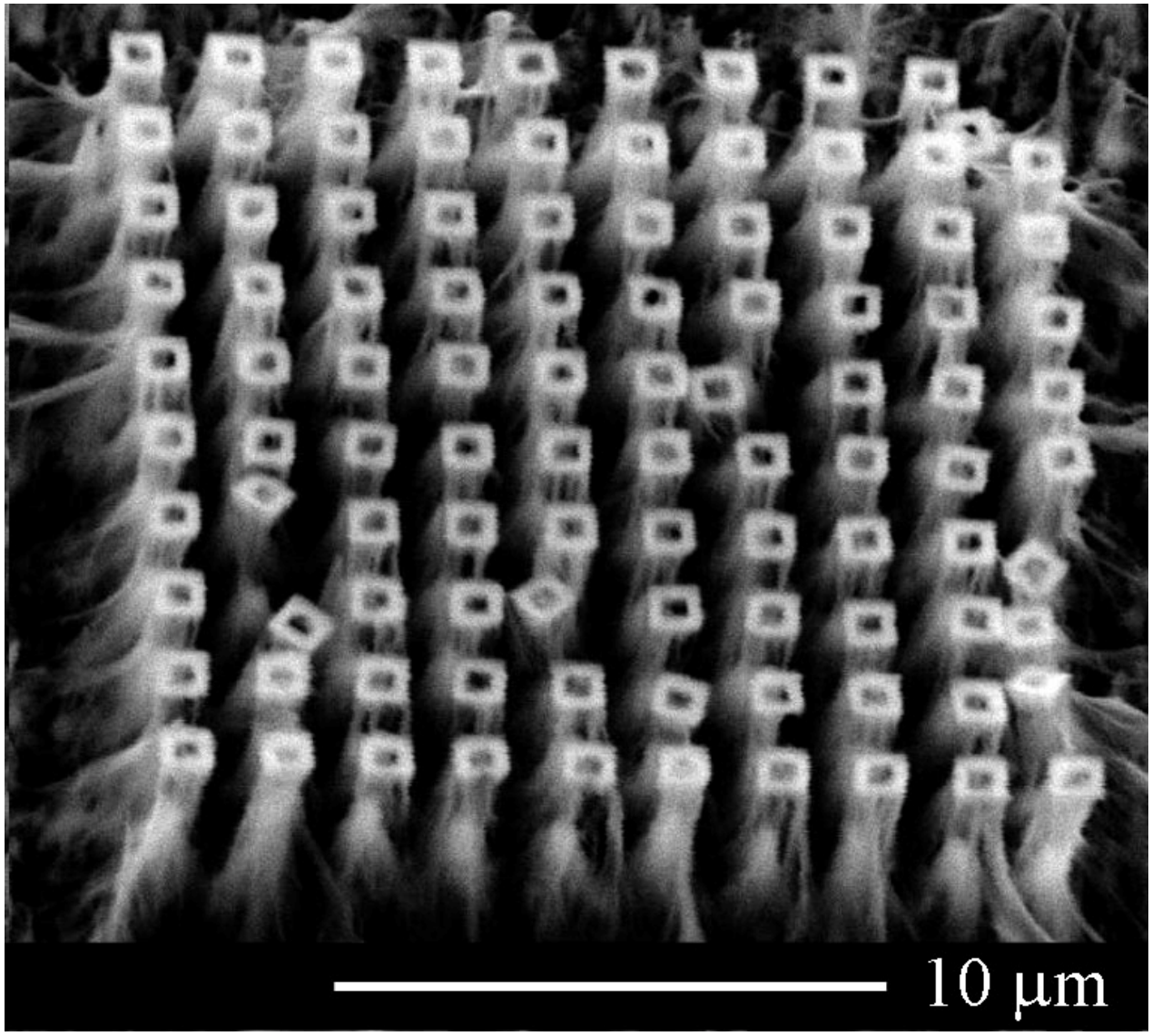


Applied Physics Letters, Vol. 86, 174102 (2005).

Network of submicrometer structures for photonic applications



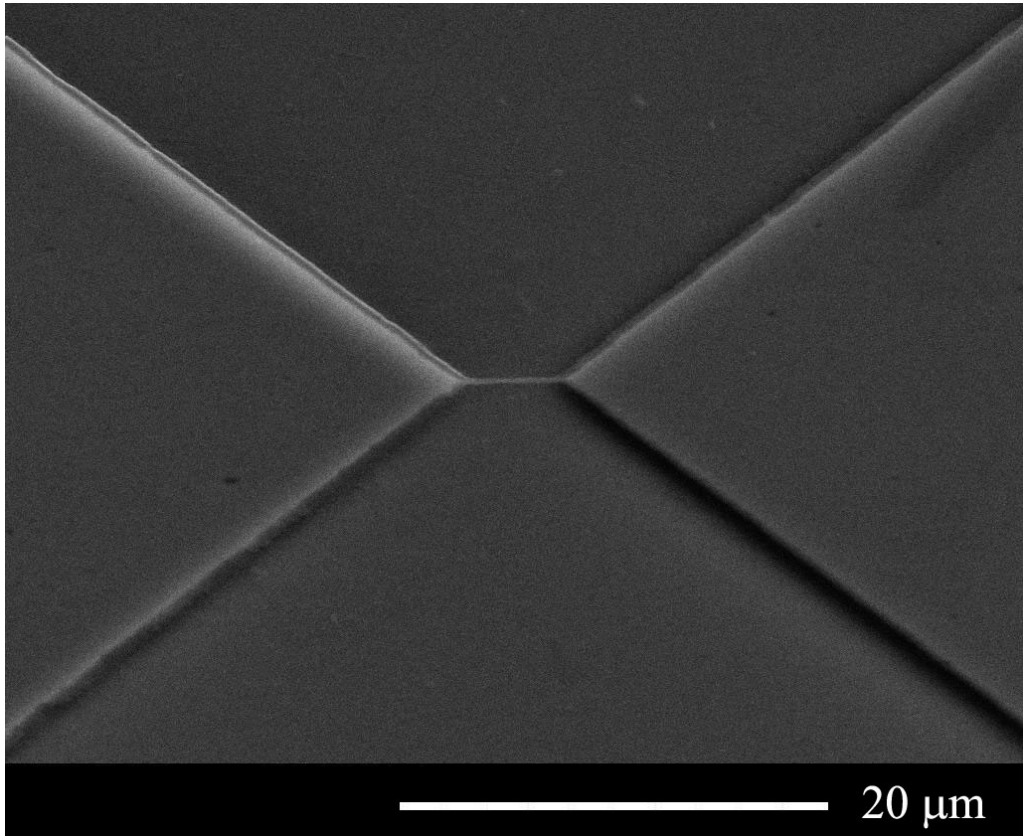
Hollow square membranes of GaN supported only by whiskers

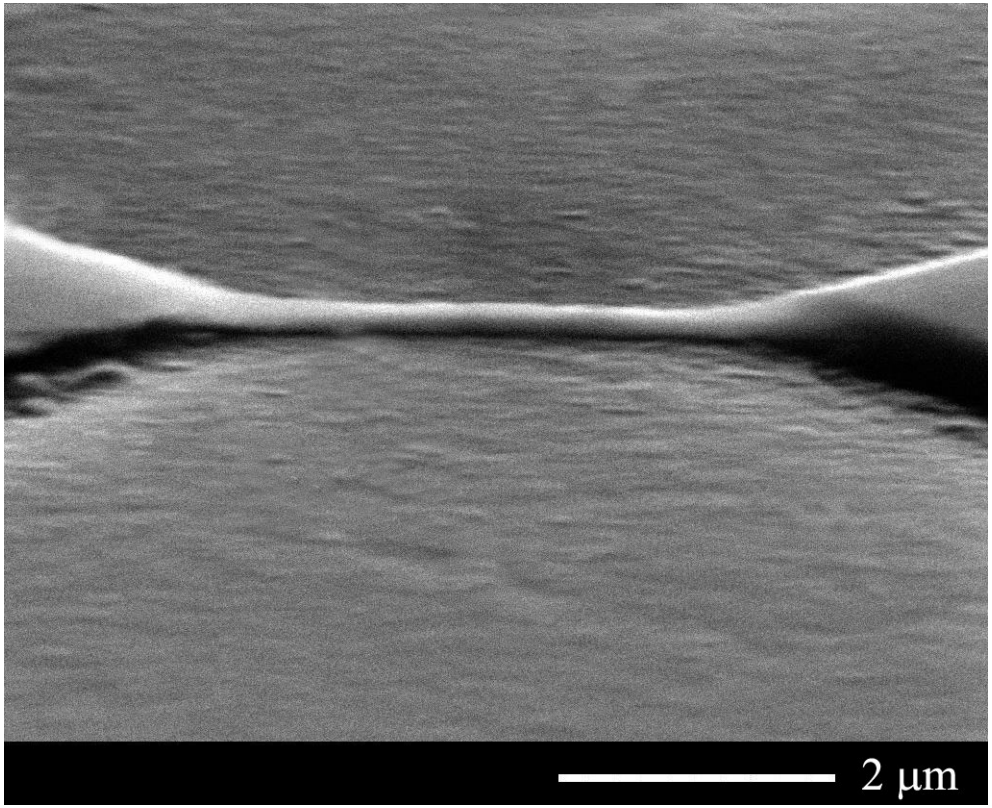


Proc. SPIE, Vol. 7216, 72160Y (2009).

GaN nanowire prepared using SCL

top view





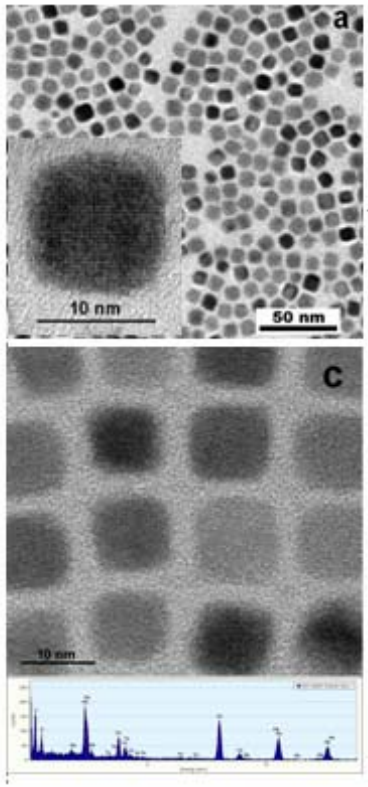
magnified lateral view

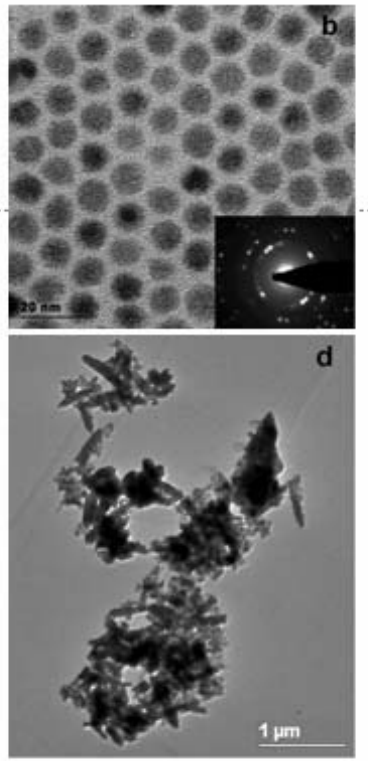
Growth of semiconductor dots for a new generation of solar cells

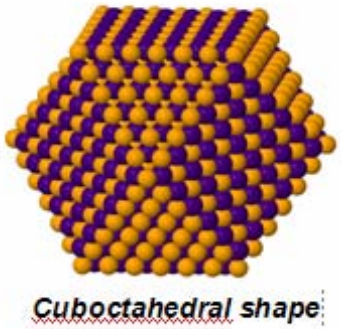
Au fost elaborate tehnologii de sinteză a nanocristalelor calcogenidelor de plumb, caracterizate prin reproductibilitate şi randament înalt de obținere a punctelor cuantice PbSe/PbS şi PbTe cu mono-dispersie dimensională omogenă.

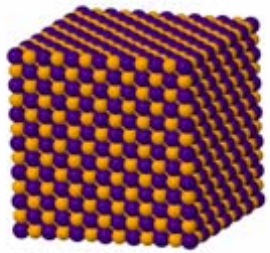
temperatura	dimensiunile
•200 ^{0}C	10 nm
•180 ^{0}C	7.2 nm
•160 ^{0}C	6,6 nm
•140 ^{0}C	< 3 nm

Datele XRD corelează cu datele TEM






Cuboctahedral shape


Cubic shape

Micro-lasers based on ZnO

- Au fost obținute noi structuri de micro şi nanolasere în baza de ZnO. Avantajul structurilor studiate țin de reducerea dimensiunilor rezonatorului laser, micşorarea pragului de emisie stimulată, extinderea diversității nanorezonatoarelor pentru utilizare în circuite optoelectronice şi fotonice.

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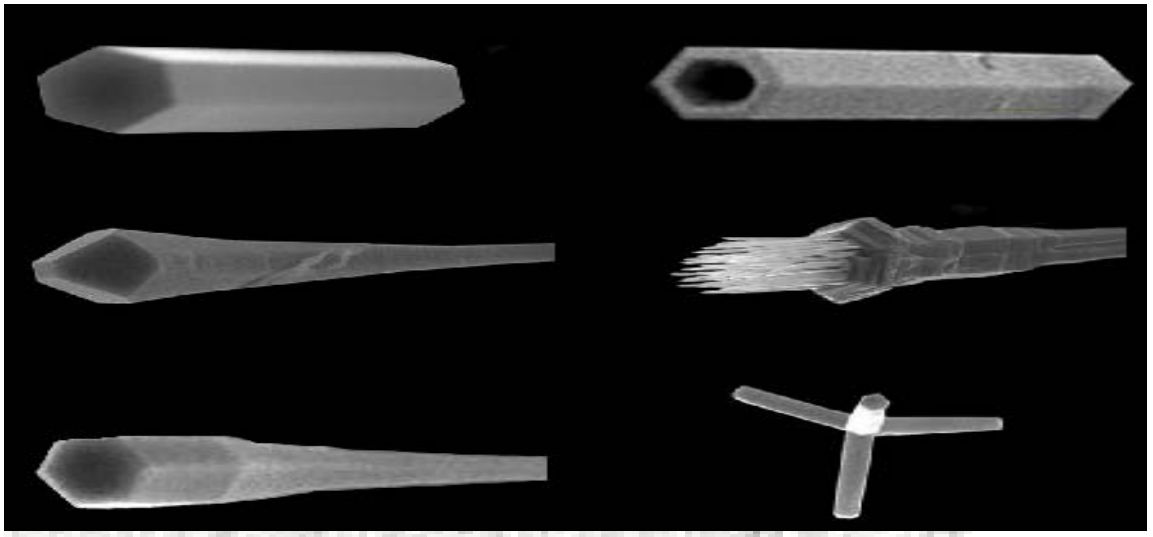
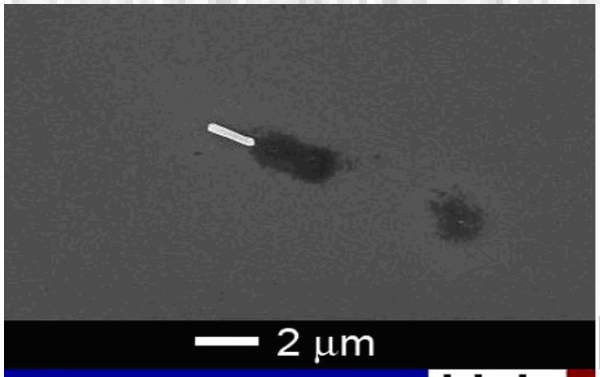
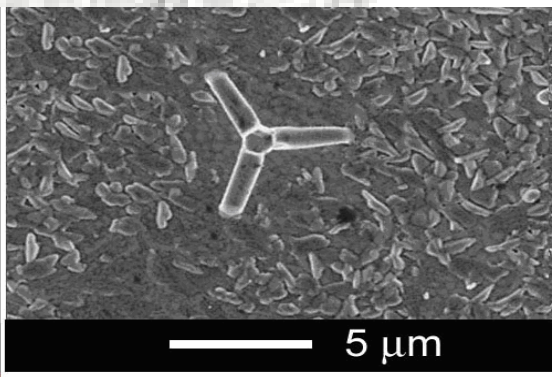
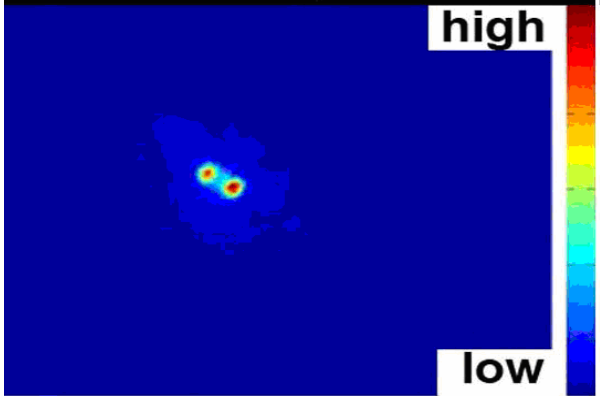
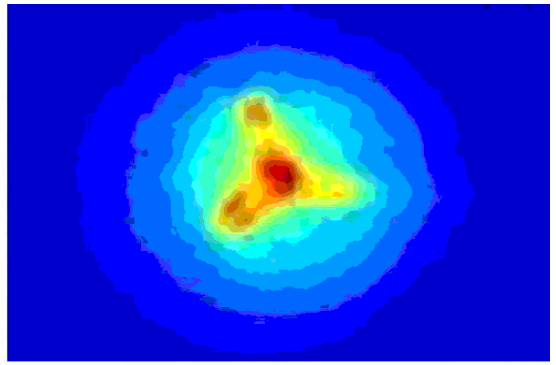


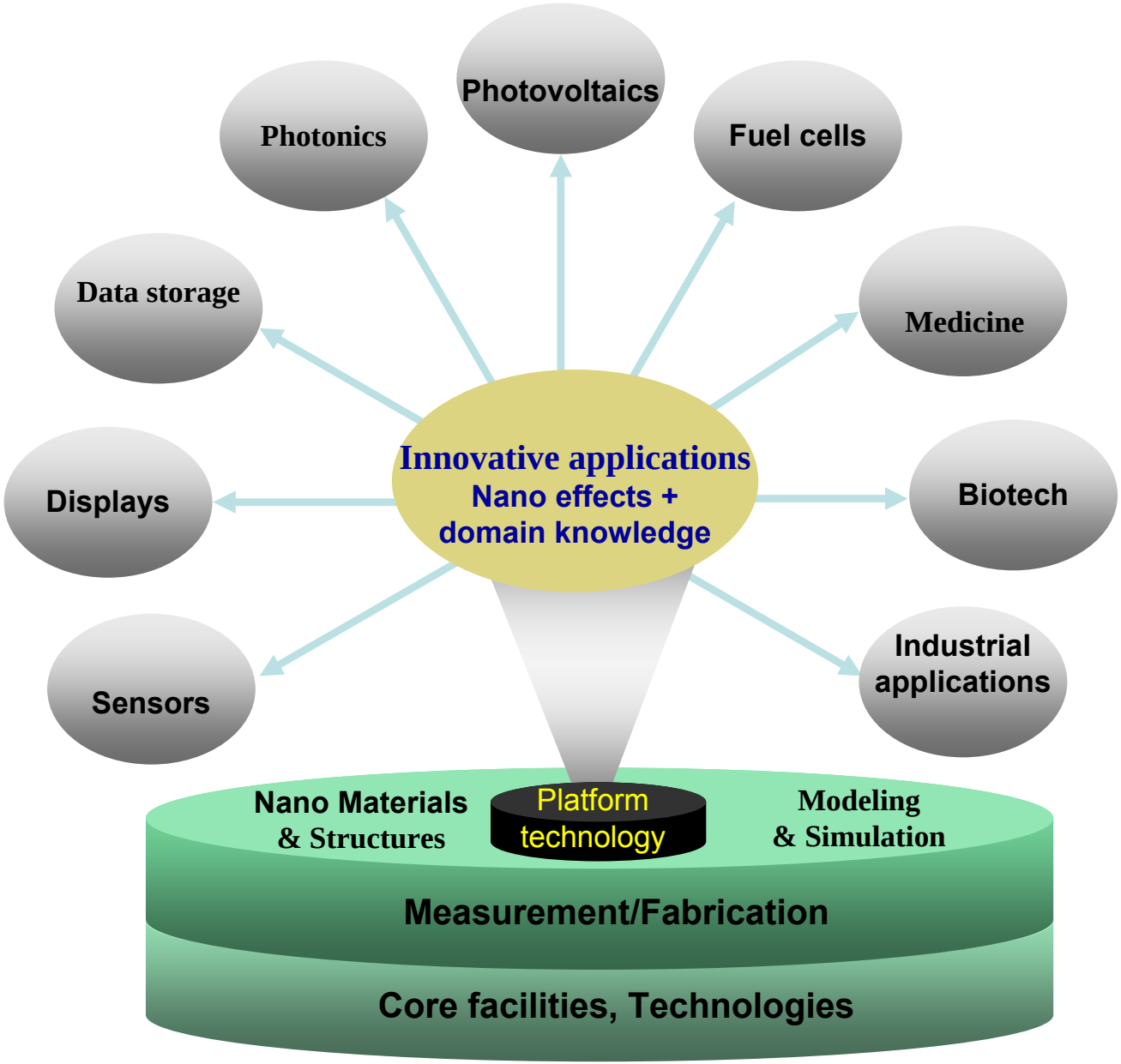








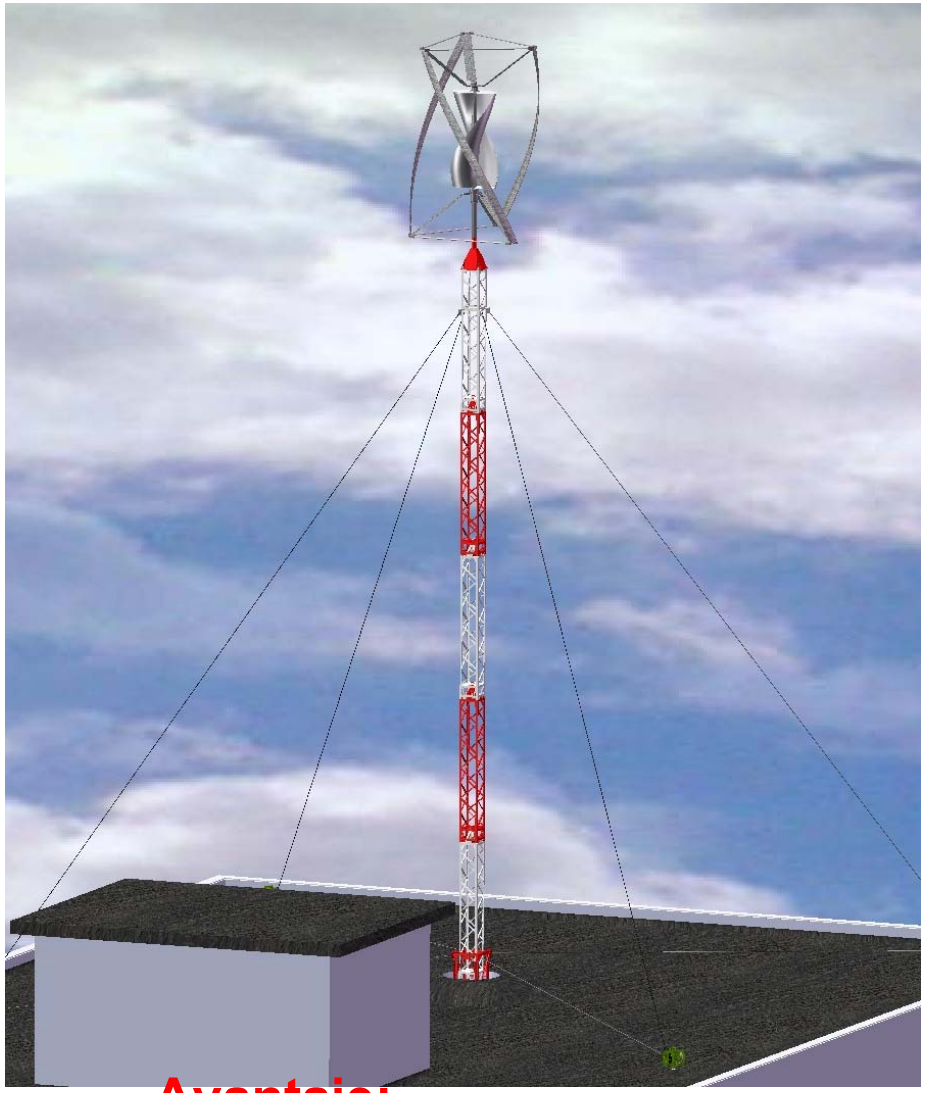
Nanotechnology Platform

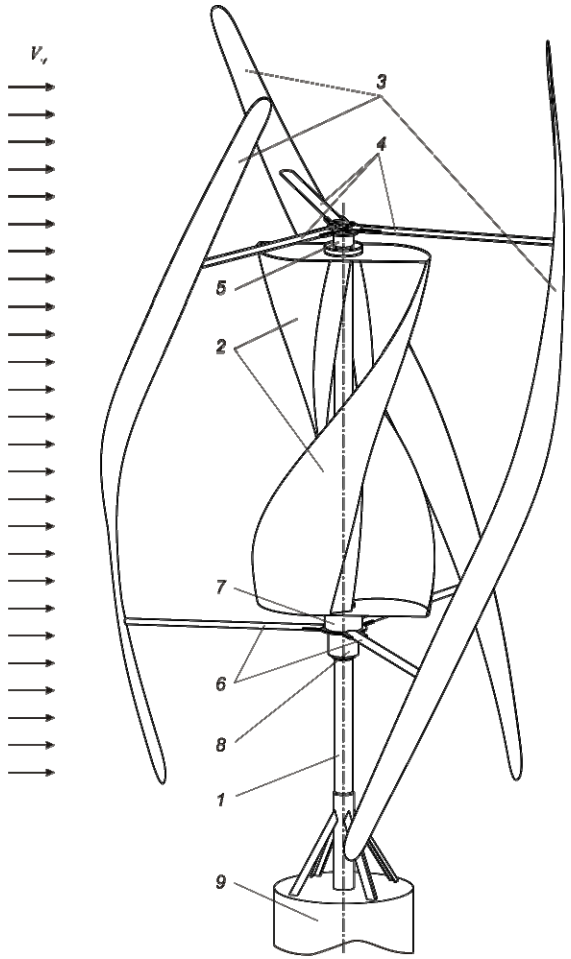


Micro-hydro power station

(diametrul rotorului *D = 4m*, înălțimea submersată a palei *h = 1,4m*, lungimea cordului palei *l =1,3 m*) (MHCF D4x1,5 ME)

New types of wind power stations





Avantaje:

-majorarea coeficientului de utilizare a energiei eoliene;

- uniformitatea rotirii organului de lucru;

-zgomot şi vibraţii reduse.

Conclusions

- Development of cost-effective technologies and promising nanomaterials;
- Progress in developing semiconductor nanotemplates for nanofabrication;
- Pronounced tendencies in diminishing the diameter of glass-coated metal microwires and fabrication of ordered arrays of metal nanowires;
- Elaboration of metal-semiconductor and polymer-semiconductor nanocomposites for optoelectronic applications;
- Development of new laser materials and rare-earth-doped fiber amplifiers;
- Growth and characterization of magnetic materials;
- Building of new coordination and supramolecular polyfunctional compounds;
- Photothermoplastic recording as a tool of color imaging using vitreus chalcogenide semiconductors as photosensitive layers;
- Elaboration and characterization of novel device structures.

Thank you

for your kind attention!