Nanotechnologies and innovations in the Republic of Moldova

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Outline

1. Reforms in science in the Republic of Moldova
2. Innovative system in Moldova
3. Nanotechnologies in Moldova: main players
4. Achievements in the field of nanotechnologies in the Republic of Moldova
5. New State Program on Nanotechnologies and Nanomaterials in Moldova
6. Conclusions

REFORMS IN SCIENCE

in the Republic of Moldova

The Low on Science and Innovation

Ratified by the Parliament on July 15, 2004

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

Reforms in Science and Innovation in Moldova

Optimization of the network of research institutions (38 institutes at present)

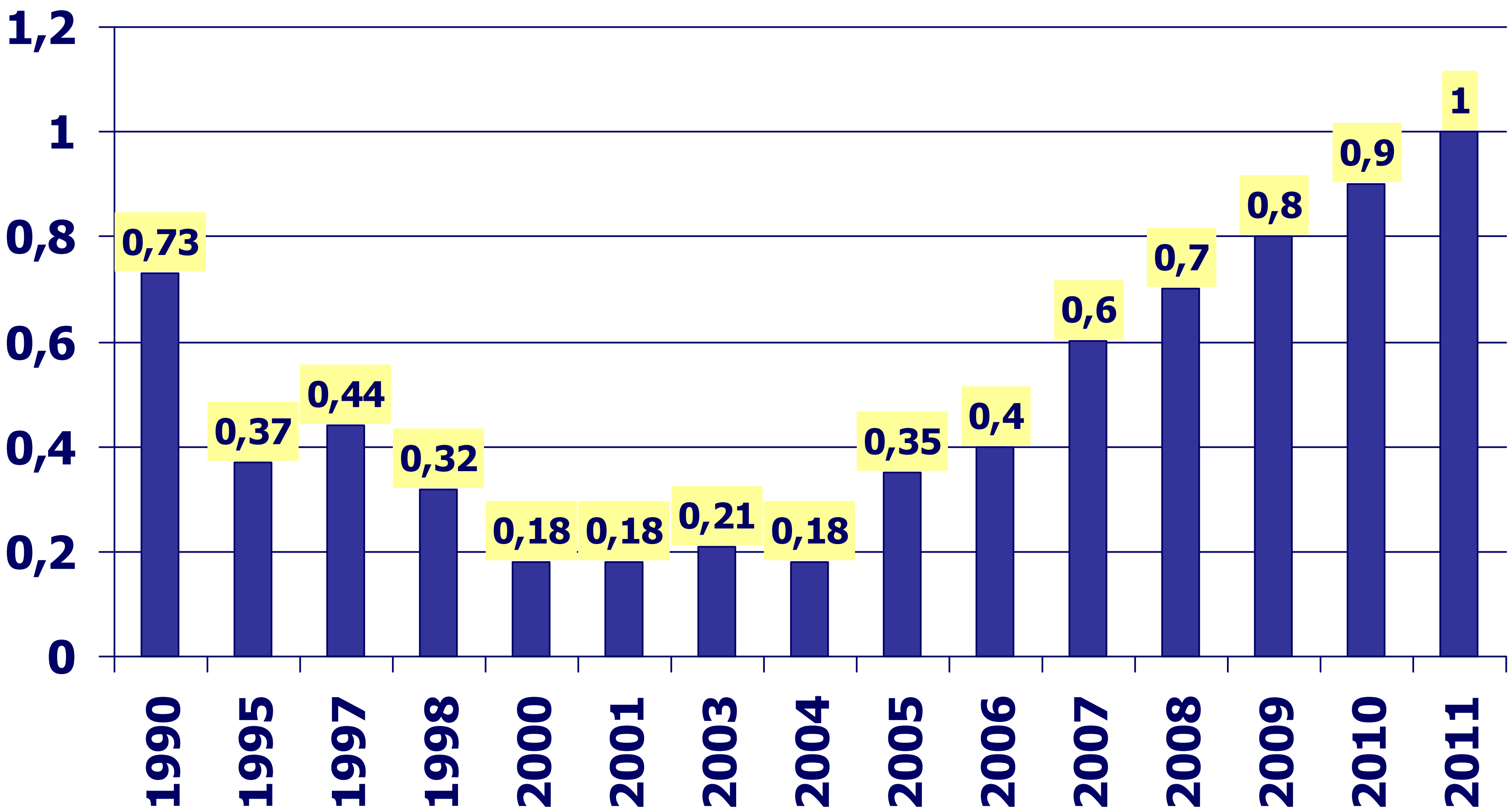
Accreditation of the research institutions

Promotion of new strategies and lows

- **Strategy of Industrial Development of Moldova**
- **Strategy of the Development of Agriculture**
- **Strategy for the Development of Renewable Energy Sources**

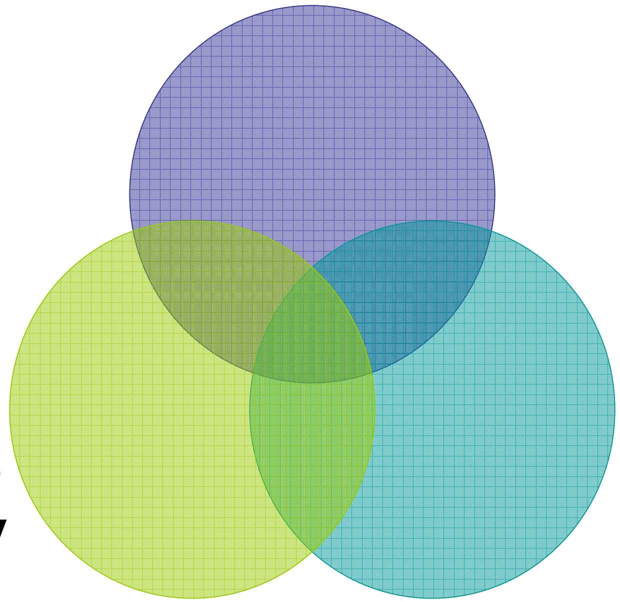
Low on Technology Parks and Business Incubators

Dynamics of Science Financing



Innovative system in Moldova

Agency for Innovations and Technological Transfer



Science and Technology Parks

Innovation Incubator

LAW ON TECHNOLOGY PARKS AND INNOVATIVE INCUBATORS
No. 138-XVI of 21.06.2007

Important peculiarities

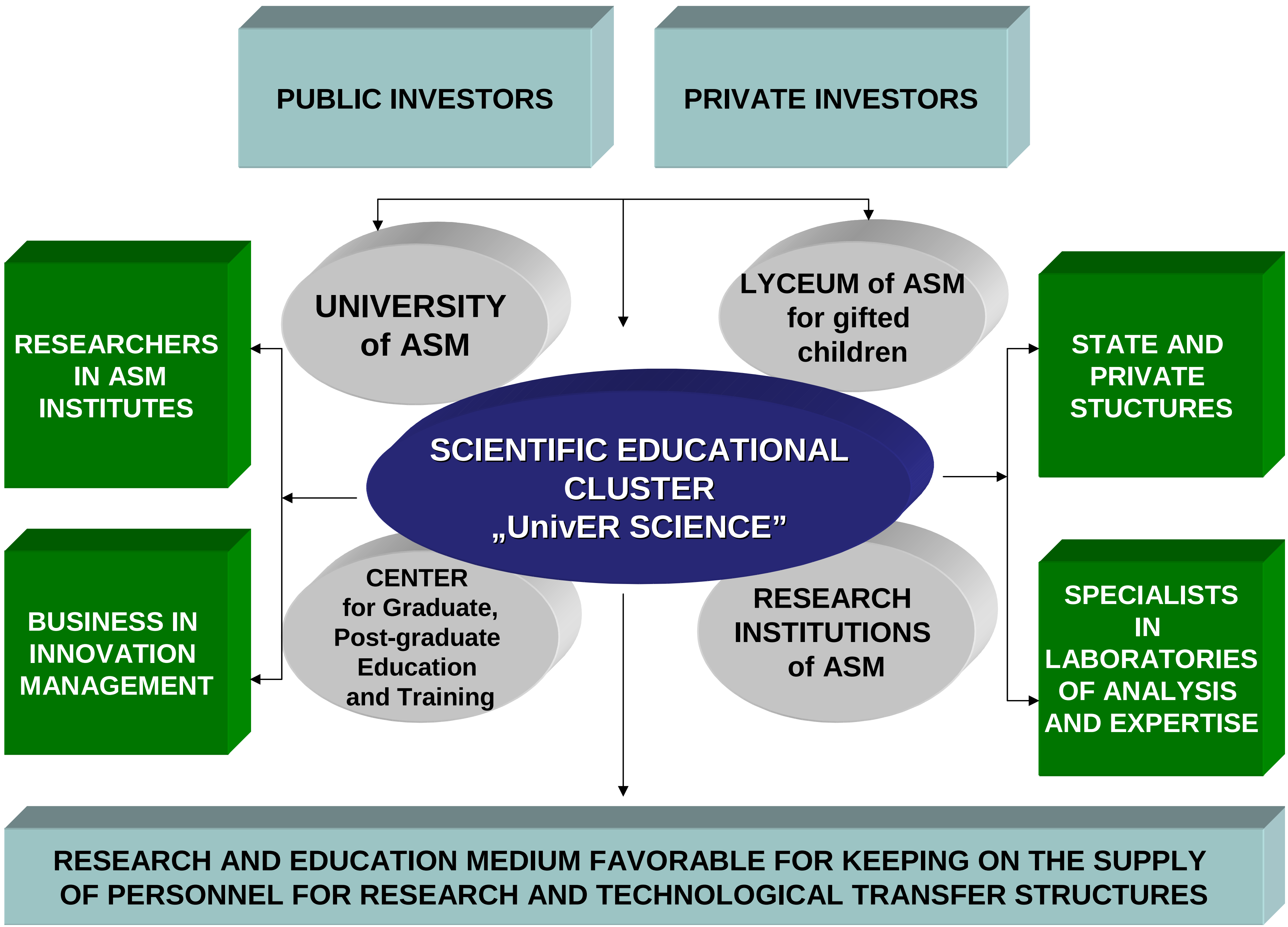
1. **Geographical freedom.**
2. **Fiscal and customs facilities:**
   - **Exemption from payment of VAT (20 %) on goods and services imported from abroad;**
   - **Exemption from payment of VAT (20 %) on goods and services bought on the territory of the Republic of Moldova;**
   - **Exemption from payment 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
UNIVERSITY of ASM
LYCEUM of ASM for gifted children
RESEARCHERS IN ASM INSTITUTES
STATE AND PRIVATE STUCTURES
SCIENTIFIC EDUCATIONAL CLUSTER „UnivER SCIENCE”
CENTER for Graduate, Post-graduate Education and Training
RESEARCH INSTITUTIONS of ASM
BUSINESS IN INNOVATION MANAGEMENT
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 gifted children;
- University of ASM;
- Research institutions;
- Science and Technology Parks;
- Innovative incubator.

Nanotechnologies in Moldova: Main players

Nanoscience and nanotechnology in Moldova

- **Nanoelectronics Nanooptics**
  - Institute of Applied Physics of the Academy of Sciences of Moldova
  - Institute of Electronic Engineering and Industrial Technologies
  - Technical University of Moldova
  - ELIRI, Topaz, Microwire – Industrial Technologies S.R.L., InformInstrument
- **Nanochemistry**
  - State University of Moldova
  - Institute of Chemistry of the Academy of Sciences of Moldova
- **Nanobiology**
  - State University of Moldova
  - State University of Medicine and Pharmaceutics “N. Testemitanu”
  - Institute of Microbiology and Biotechnology of the ASM
  - “Ficotehfarm”

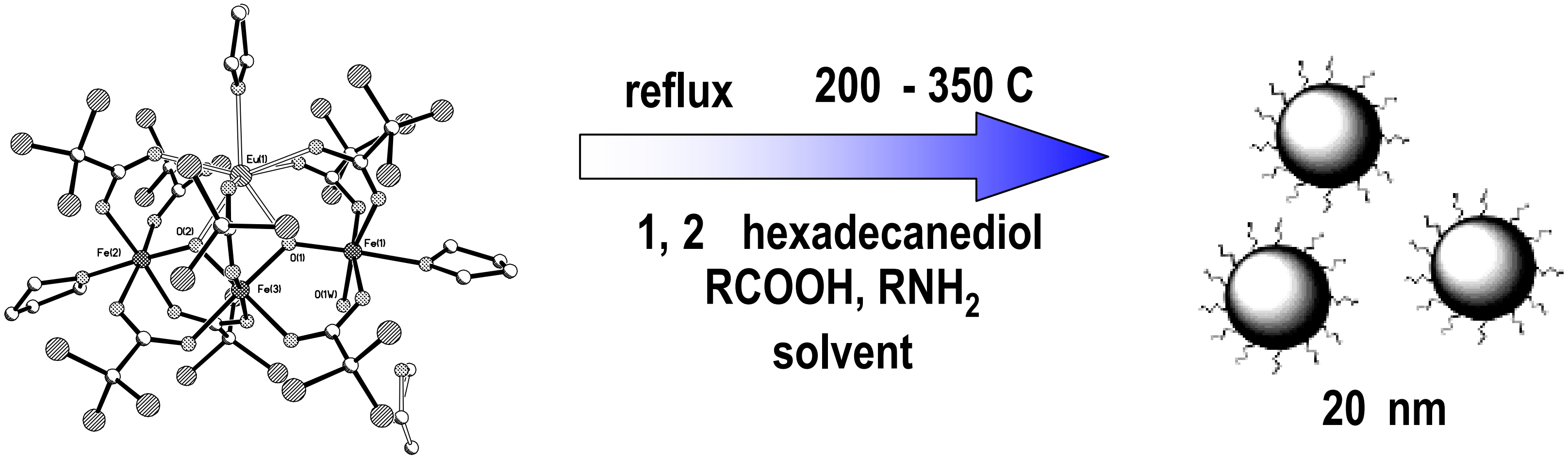
Nanoscience and nanotechnology in Moldova

- Nanoelectronics Nanooptics
  - Semiconducting nanotemplates
    - Nanocomposites
    - Nanoheterojunctions
    - PECC
  - Semiconducting, metallic, semimetallic nanowires and integrated arrays
  - Sensors
  - Nanostructured electrodes for electrosparking alloying
- Nanochemistry
  - Nanomaterials based on heterometallic coordinative combinations
    - New multifuctional materials
- Nanobiology
  - Nanotechnologies for the synthesis of Fe containing coordinative compounds
    - Growth of biomass with controlled Fe contents
    - Fabrication of drugs and antianemic pharmaceutics

Achievements in the field of nanotechnologies in the Republic of Moldova

Nanotechnologies in the Republic of Moldova

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

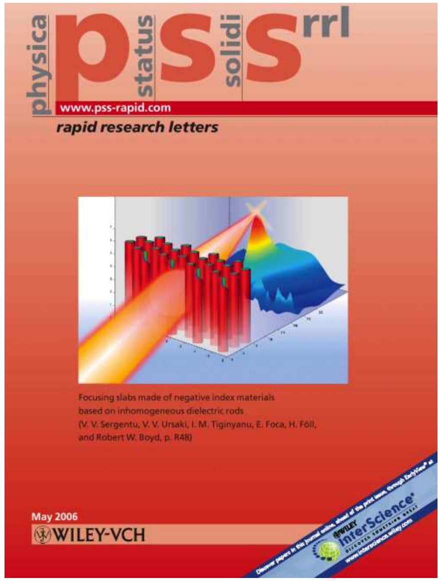


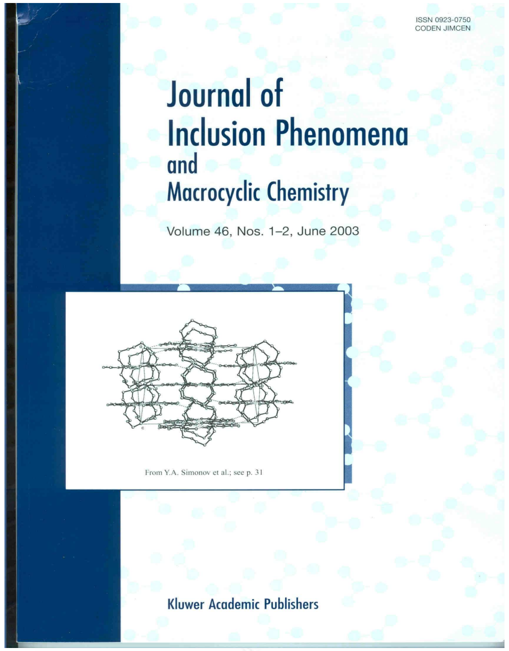
2. Technologies for layer deposition, including epitaxy

GaN ZnO GaAs InP polymers

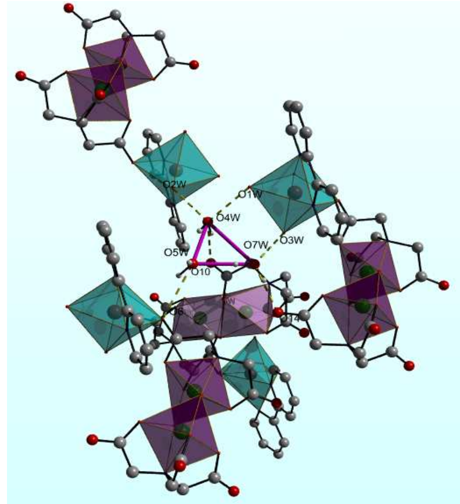
3. Methods for the fabrication of nanowires, nano-structures and integrated networks on their basis

metals semimetals semiconductors nanocompozites





Molecular magnets



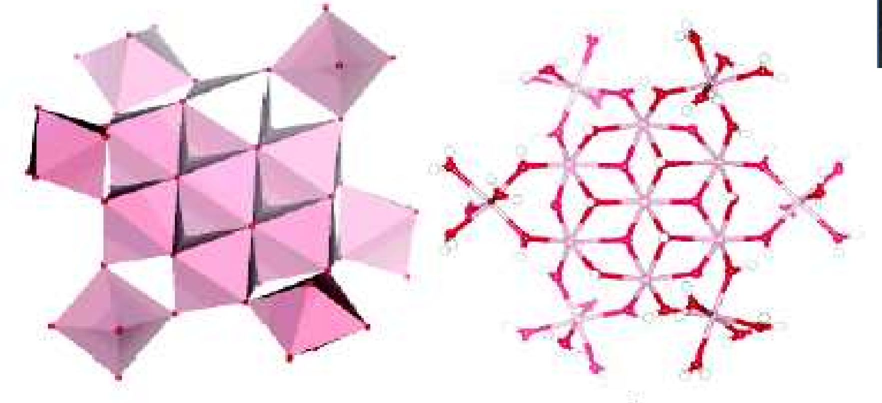
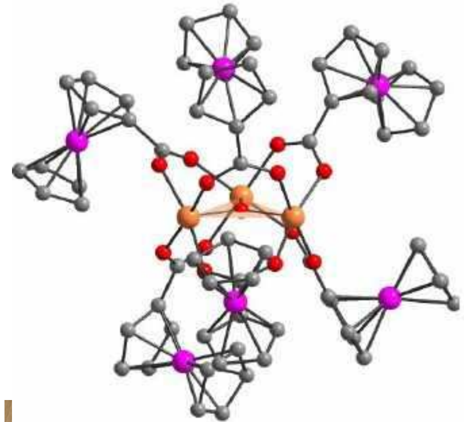
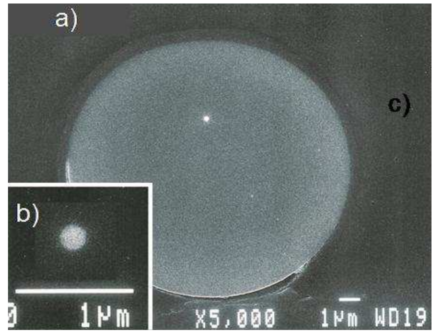
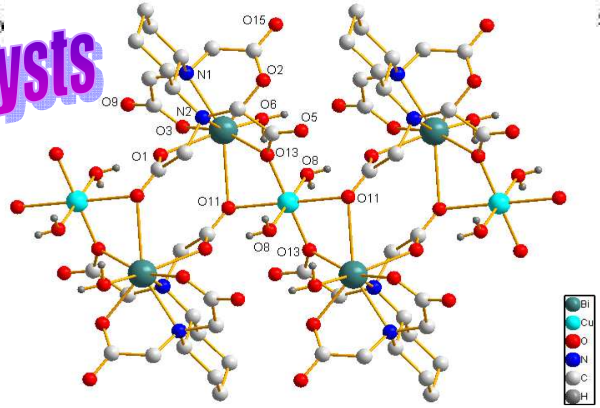


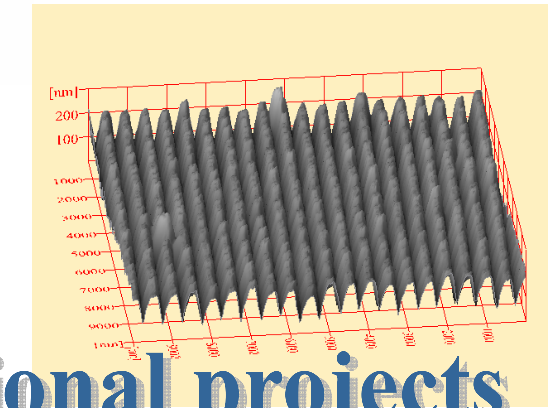
Figure 1. Polyhedral (a) and ball-and-stick (b) representations of the crystal structure o



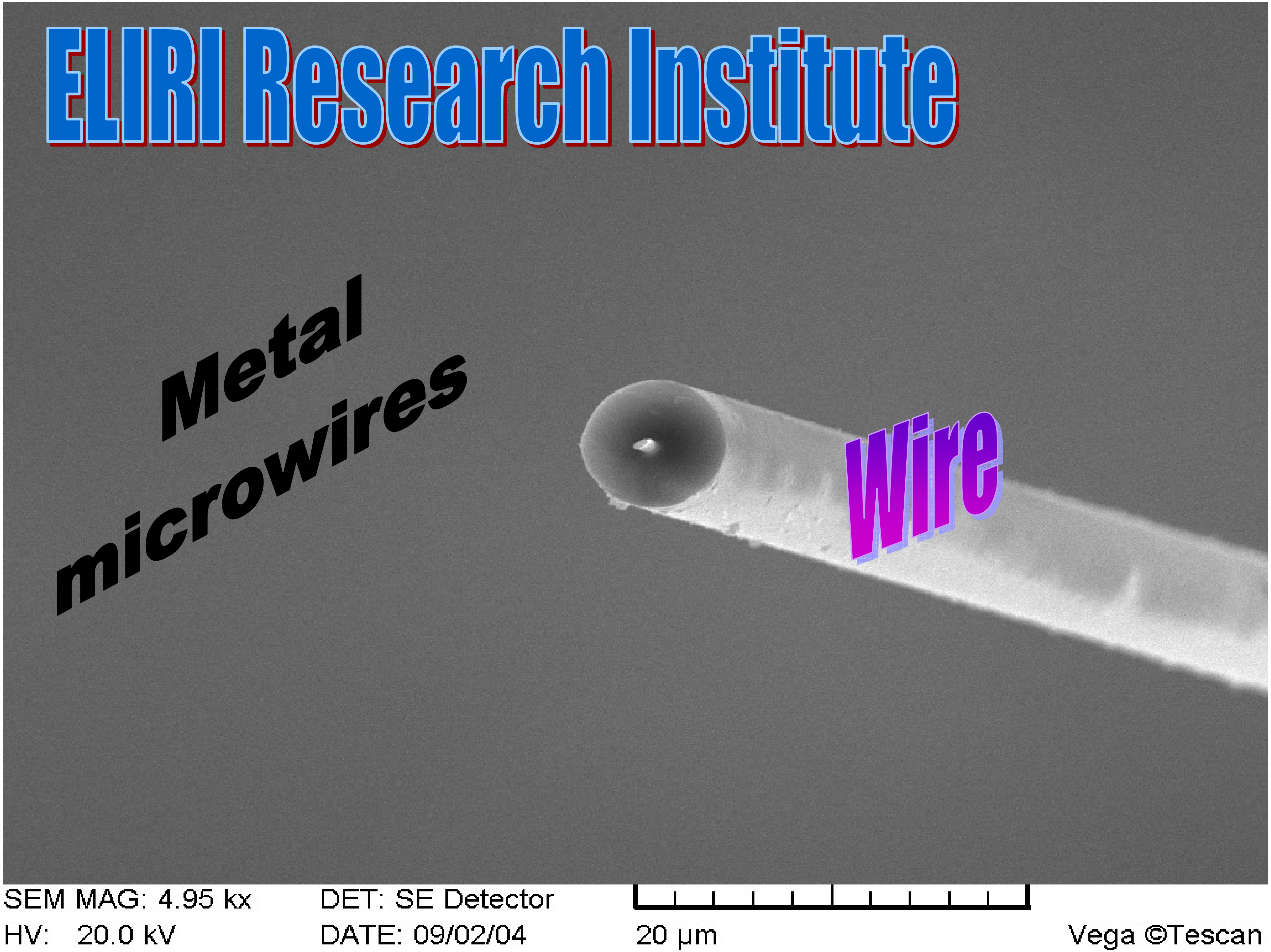


Catalysts

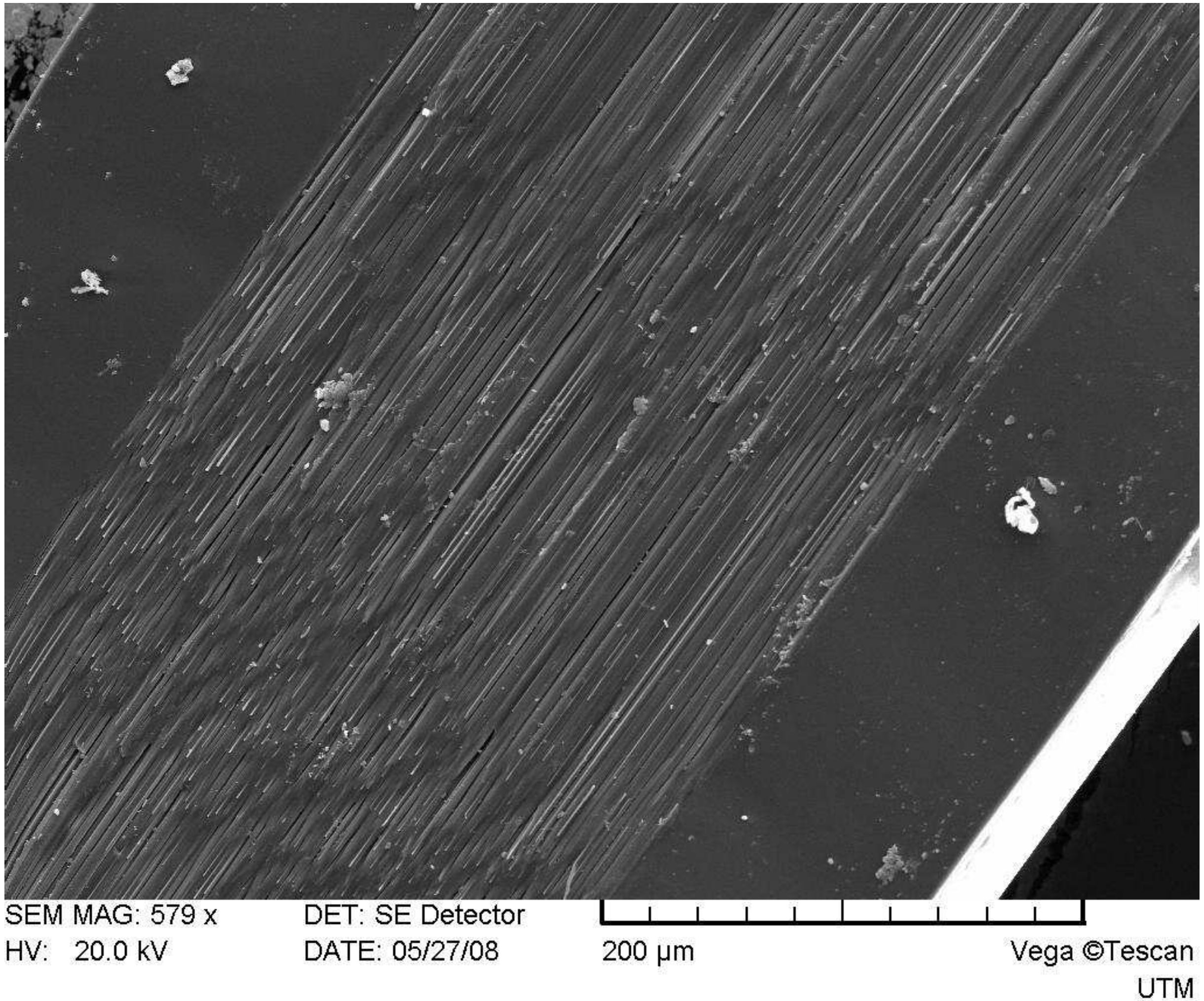


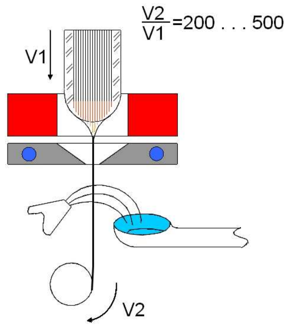


30 international projects


ELIRI Research Institute
Metal microwires
Wire
SEM MAG: 4.95 kx
DET: SE Detector
HV: 20.0 kV
DATE: 09/02/04
20 µm
Vega ©Tescan

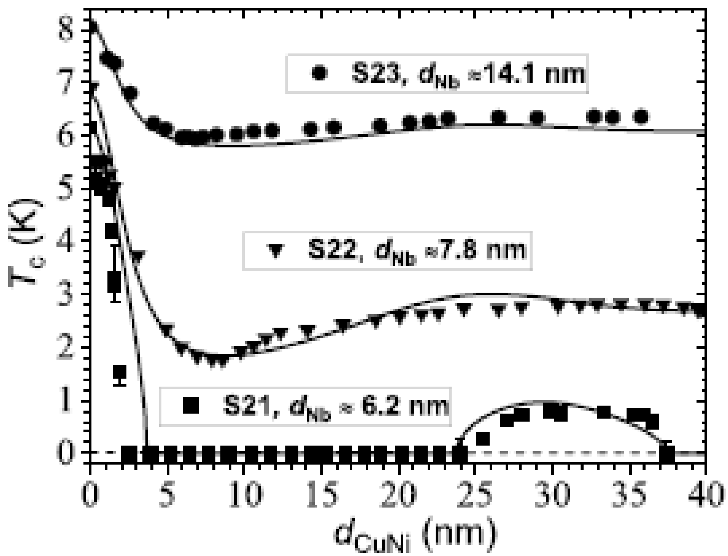
Micro-cable consisting of up to 600,000 nanowires in glass envelope

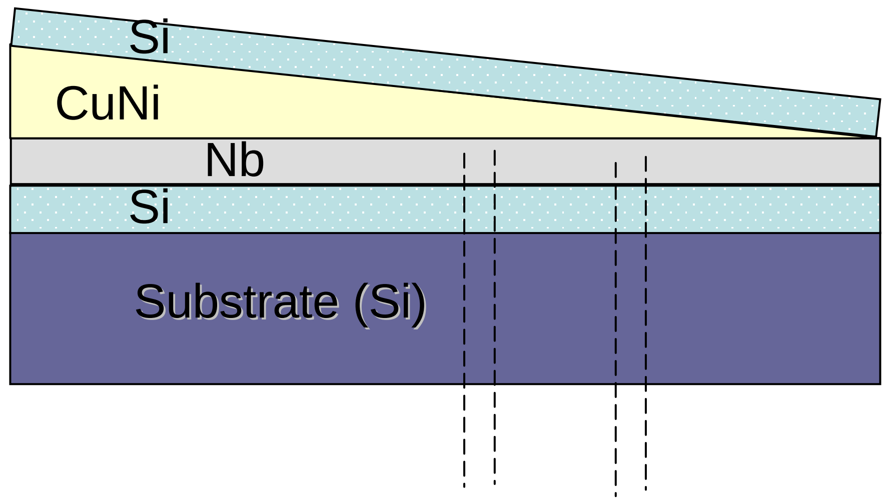




up to 600,000 nanowires

Experimental observation of the re-entrant superconductivity in Nb/$Cu_{41}Ni_{59}$ bilayers (V.I. Zdravkov, A.S.Sidorenko *et al*., PRL 97, 057004, 2006)

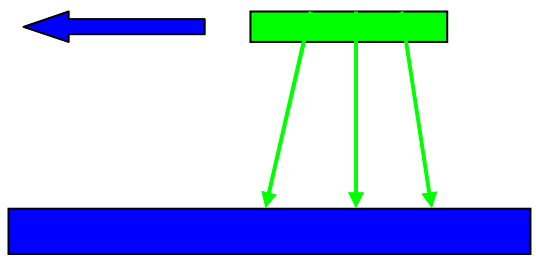




Non monotonous T_c (d_F)
(d_{Nb}≈14.1, and 8.3 nm),

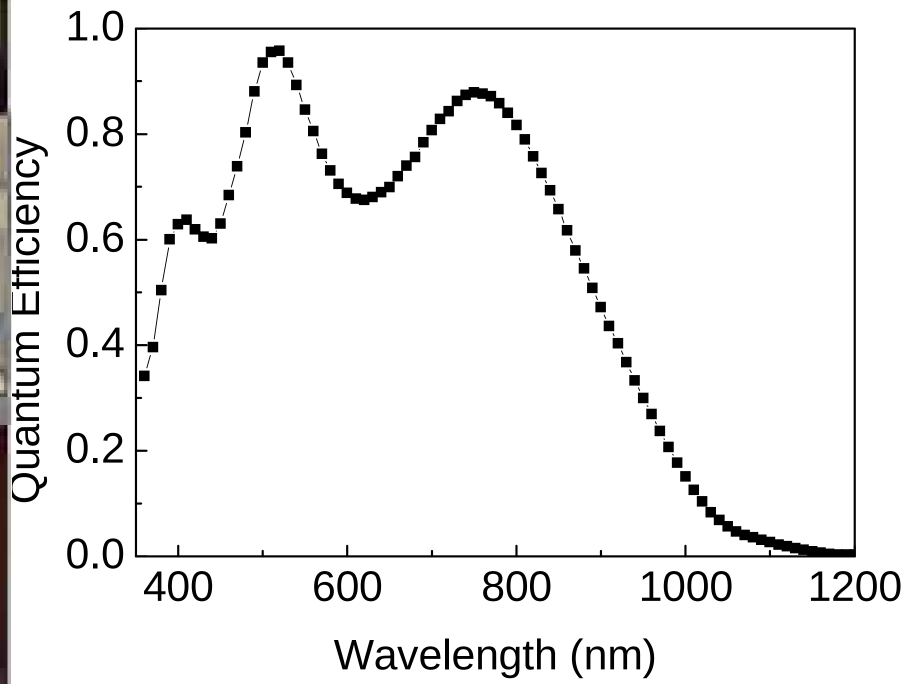
and re-entrant T_c (d_F) behavior
for d_{Nb}≈7.3 nm < ξs ~ 8 nm.

oving target:

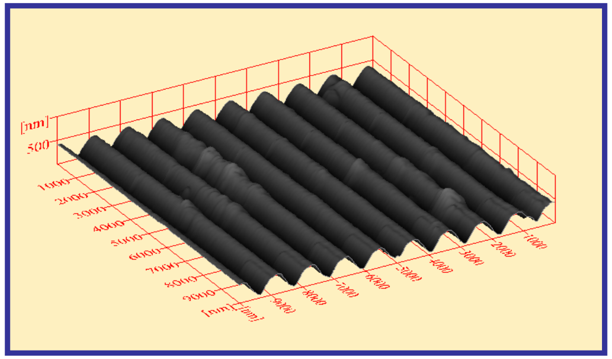


Institute of Applied Physics
State University of Moldova

n^+ITO-SiO_2-nSi SOLAR CELLS OBTAINED BY SPRAY-PIROLISYS TECHNIQUE



IAP Holographic Nanostructures

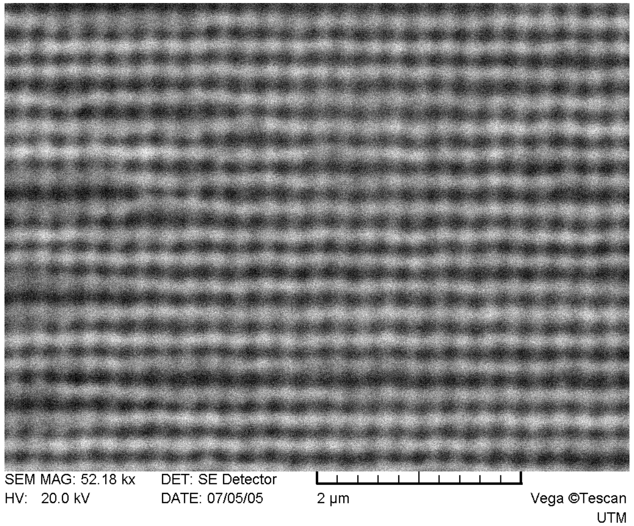


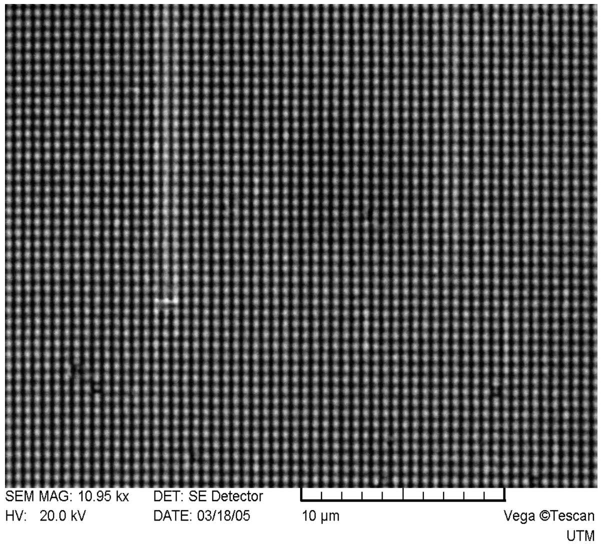
Diffraction grating: spatial frequency 1000 lines/mm

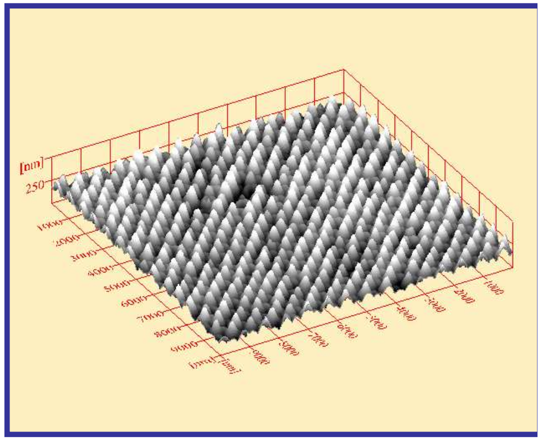
Fig. 1 Topography of holographic diffraction gratings patterns, constant of grating 1 μm.

Superimposed diffraction gratings: spatial frequency 2000 lines/mm

Fig.2,3 Superimposed gratings with grating constant 500 nm. (observed by Scanning Electron Microscope SEM and Atomic-Force Microscope AFM).



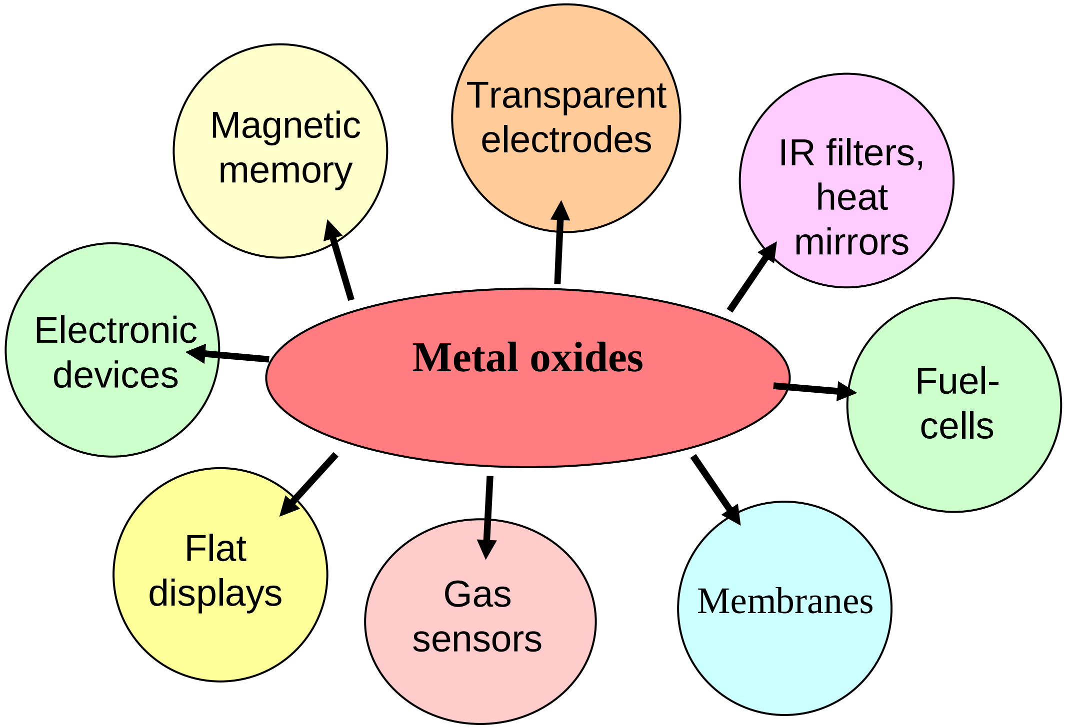




Diffraction grating: spatial frequency 4000 lines/mm

Fig. 4 Superimposed gratings, grating constant 250 nm. (observed by Scanning Electron Microscope (SEM))

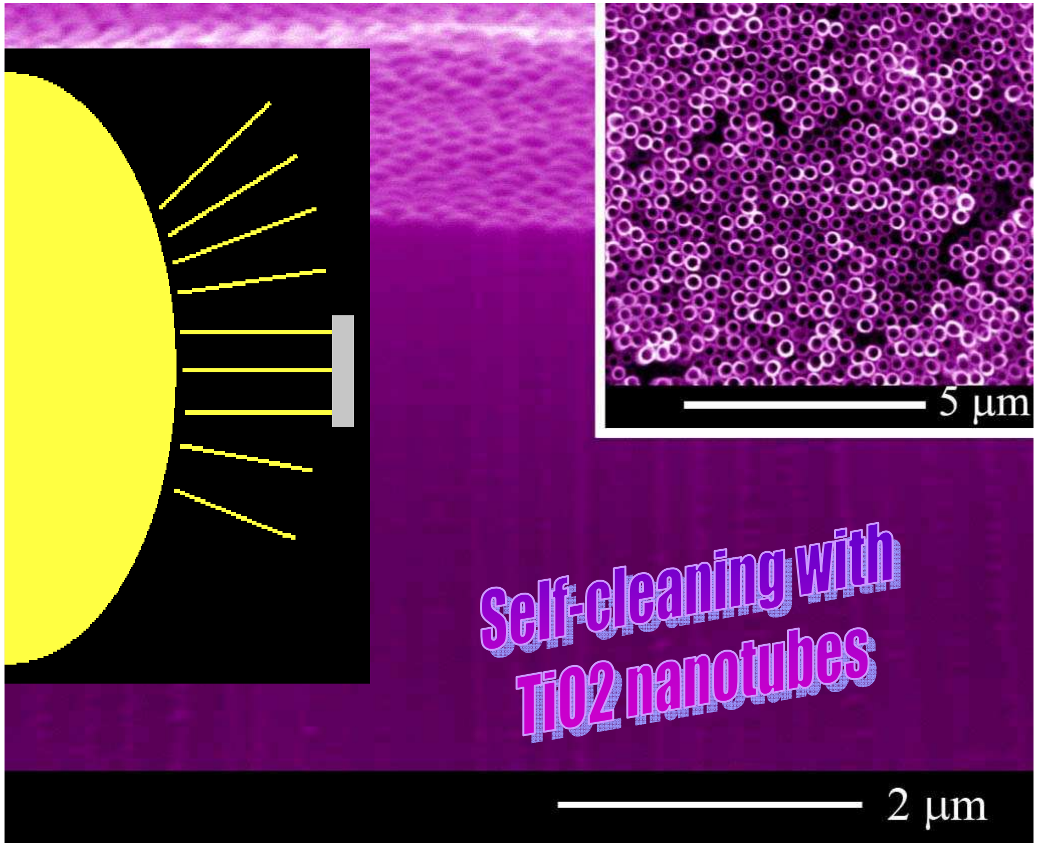
Metal oxides for various applications



SnO_2 and In_2O_3 - ***Spray pyrolysis*** (Dr. hab. Gh. Korotchenkov, TUM; Prof. D.Sherban, Institute of Applied Physics and State University of Moldova)
ZnO – ***Chemical bath deposition*** (Prof. T. Sisianu, Prof. D. Tsiulyanu, Dr. O. Lupan, TUM)

Low cost and low power consuming (P<100 mW) In2O3 and SnO2-based sensor prototypes for O3, CO, CH4, H2, smoke, fire, and vapors of organic solvents detection were developed.

National Center for Materials Study and Testing



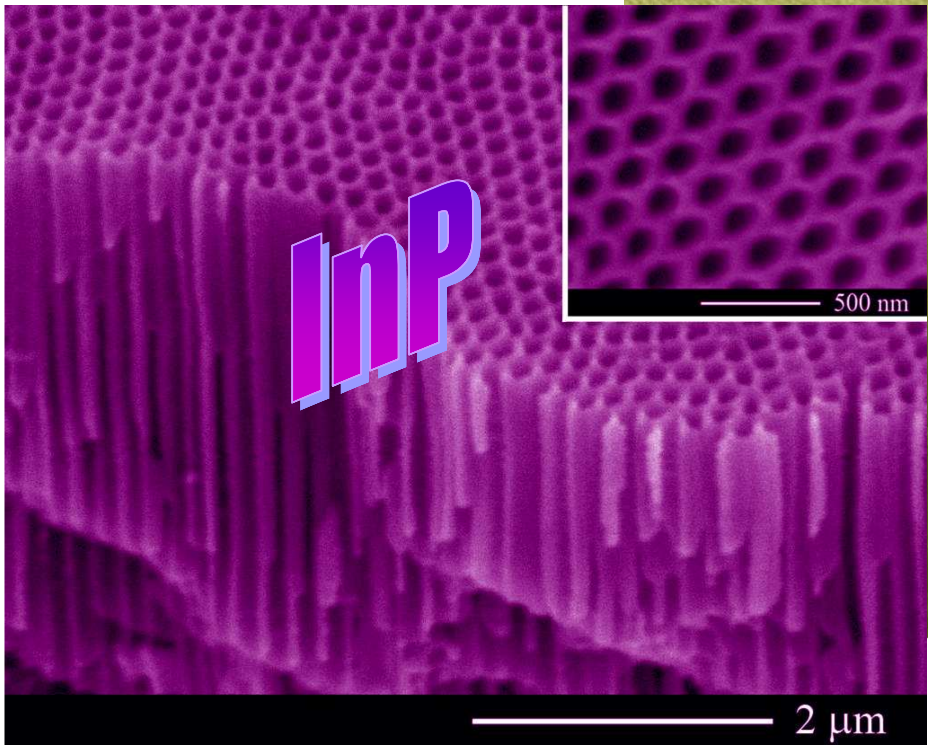
TiO2 nanotubes for photonics

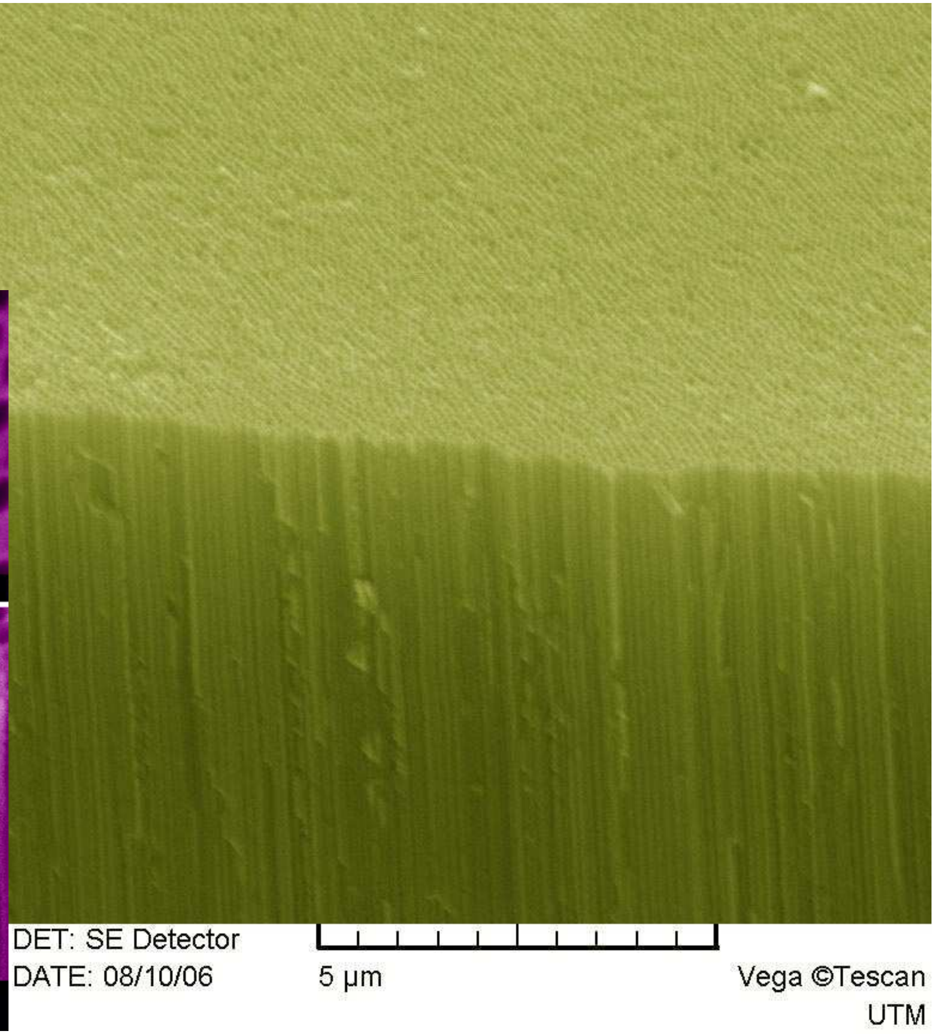
www.ncmst.utm.md

V. Sergentu, I. Tiginyanu, V. Ursaki et al
***Physica Status Solidi – RRL*, Vol. 2 (2008).**

Nanotemplates with ordered nanochannels

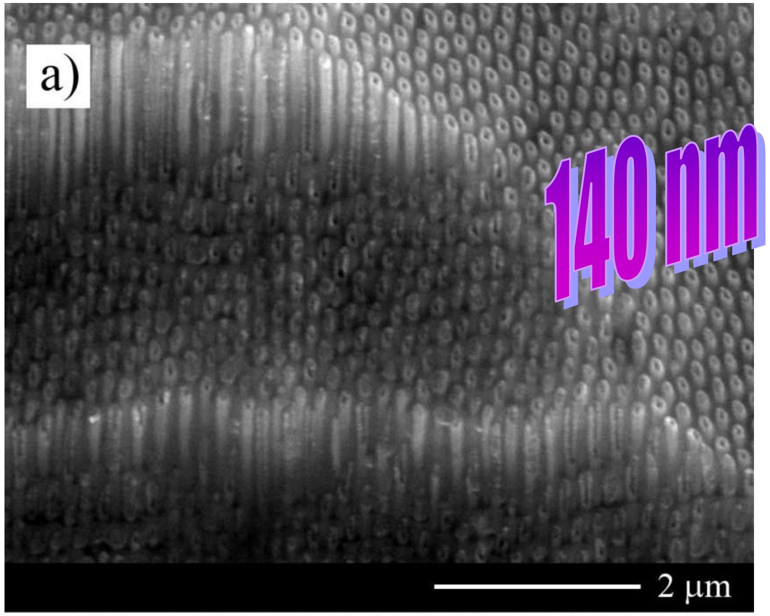
Environmentally-friendly approaches

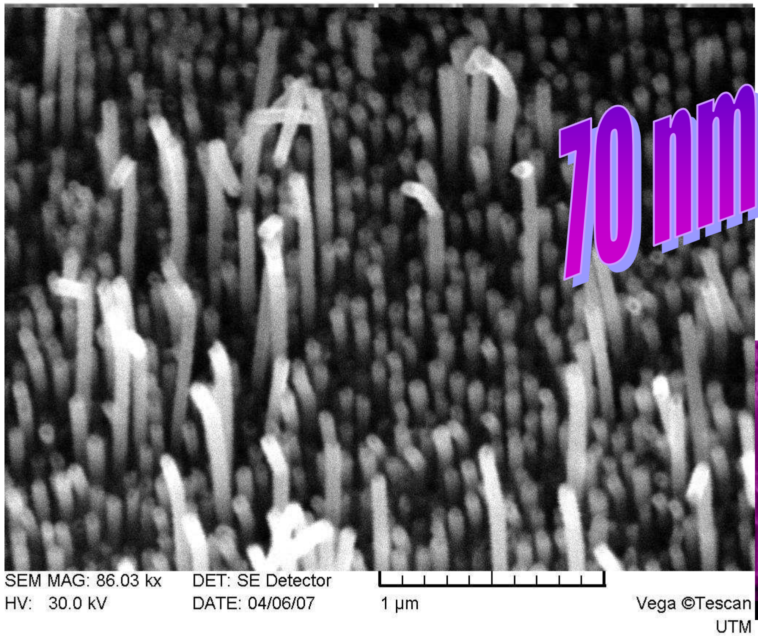


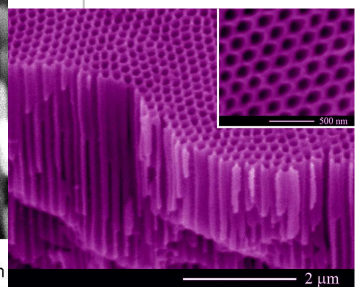


I.M. Tiginyanu et al, Physica Status Solidi (RRL), **Vol. 1, issue 3, pp. 98-100 (2007);**
Electrochemical and Solid-State Letters, **Vol. 10 (11), pp. D127-D129 (2007).**

NanoTechWeb.org







LATEST NEWS ARTICLES

- Magnetic nanoparticles seek out artery plaques
- Nanosheets get a better shot at the market
- Nanotubes on the look out for new bone
- Striped nanoparticles enter cells with ease
- Nanotubes turn up the heat on cancer

RELATED STORIES

- Nickel-filled carbon nanotubes line up for devices (December 2002)

RELATED LINKS

- Ion Tiginyanu
- Technical University of Moldova
- Institute of Applied Physics, Academy of Sciences of Moldova

RESTRICTED LINKS

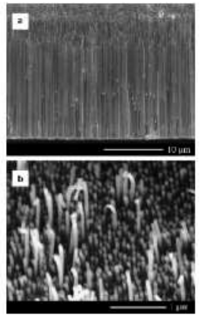
- *Electrochemistry Communications* **10** 731

TECHNOLOGY UPDATE

Jun 23, 2008

Salty water puts metal nanotubes in order

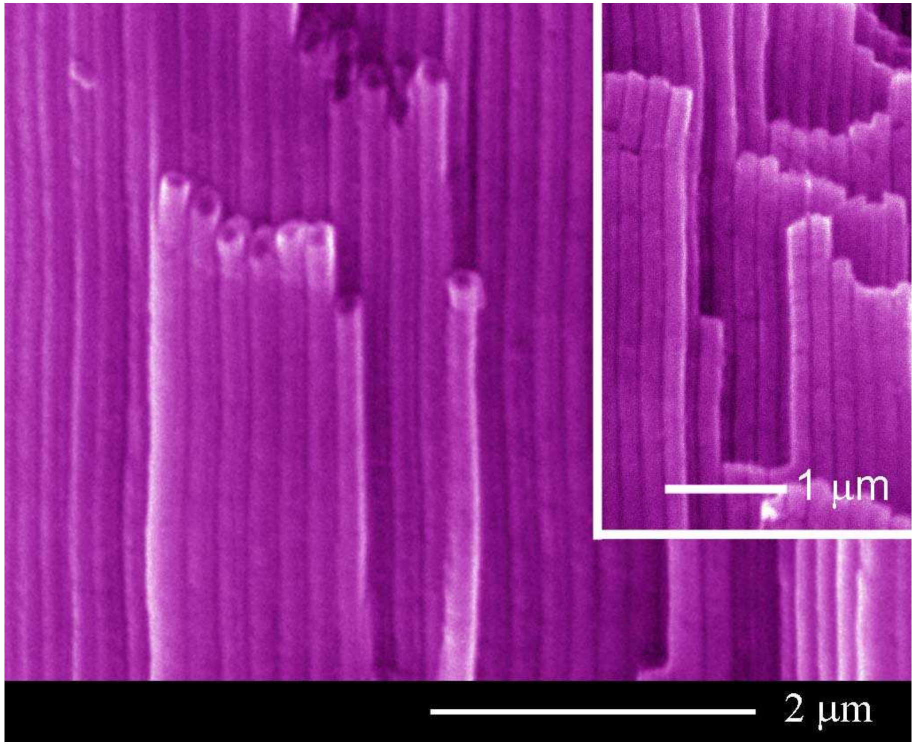
A new, simple technique to produce ordered arrays of metal nanotubes has been developed by scientists in Moldova. The method works by electroplating in conductive nanotemplates routinely fabricated by anodic etching of semiconductor substrates in salty water. The result could be important for making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

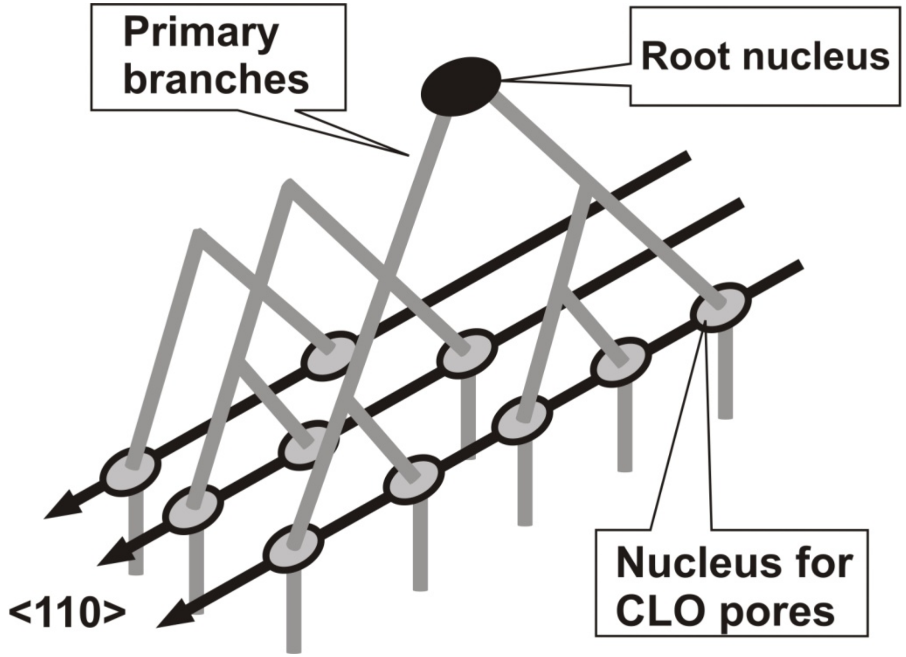


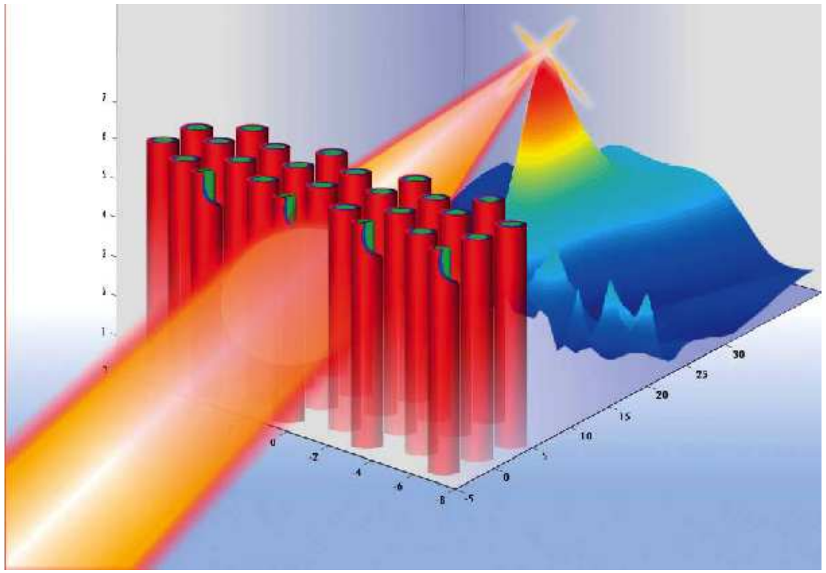
Ion Tiginyanu and colleagues from the National Center for Materials Study and Testing have developed a cost-effective and environmentally friendly nanofabrication approach for making semiconductor nanotemplates.

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.





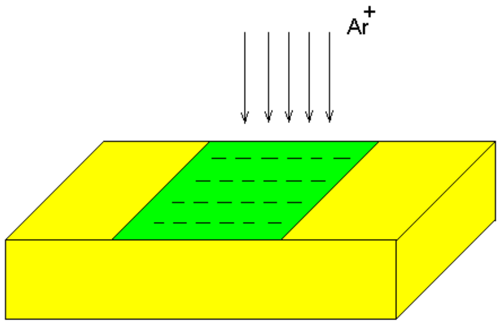


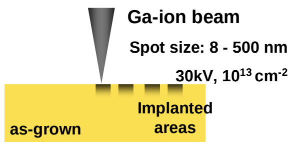
Electrochemistry Communications, Vol. 10, 731-734 (2008)

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)

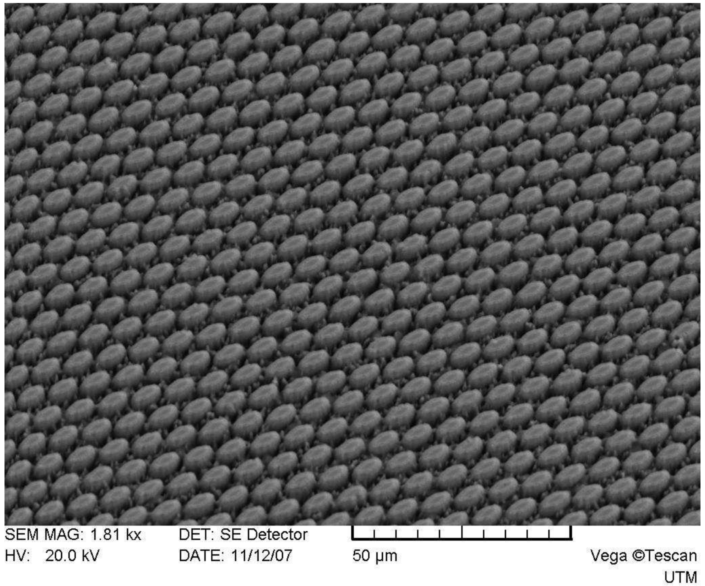
2. Photoelectrochemical etching of the FIB-treated structures

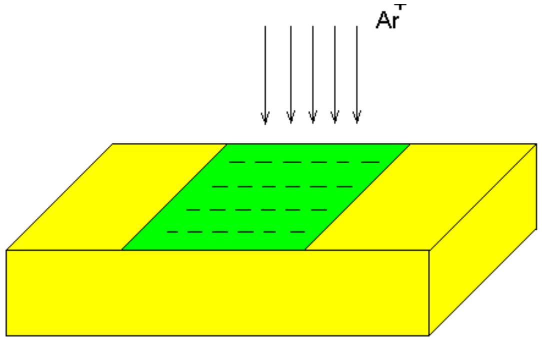
PEC etching was carried out in stirred 0.1 mol aqueous solution of KOH under in-situ ultraviolet (UV) illumination provided by focusing the radiation of a 350 W Hg lamp to a spot of about 5 mm in diameter on the GaN surface exposed to electrolyte.

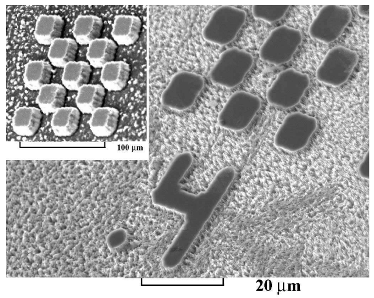
In most cases we used MOCVD-grown n-GaN layers with electron concentration of 1.7 x 10^{17} cm^{-3}, the density of dislocations was in the range of 10^9-10^{10} cm^{-2}.

Surface Charge Lithography

Gold Medal, Pittsburg, 2005



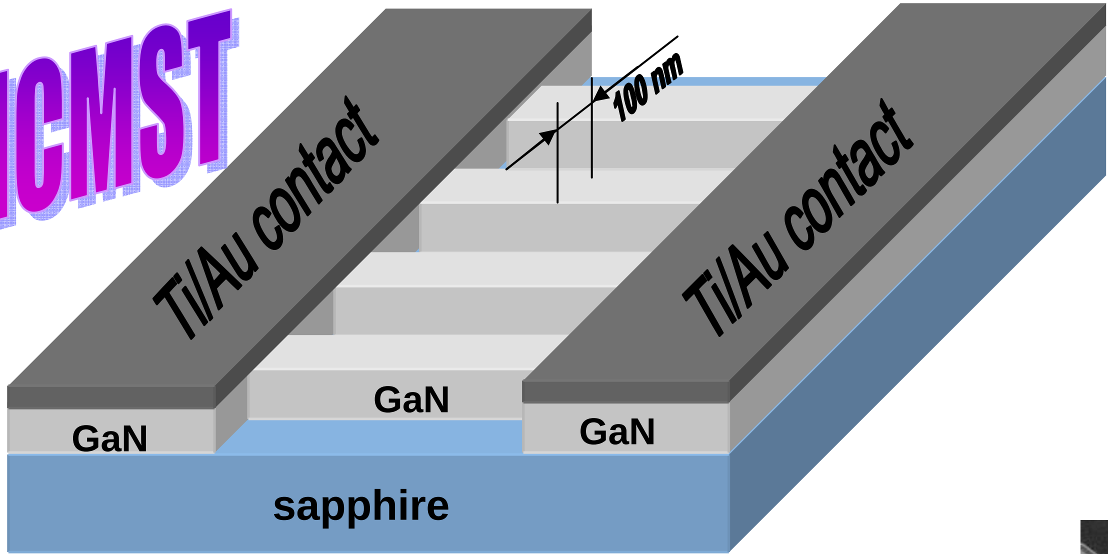


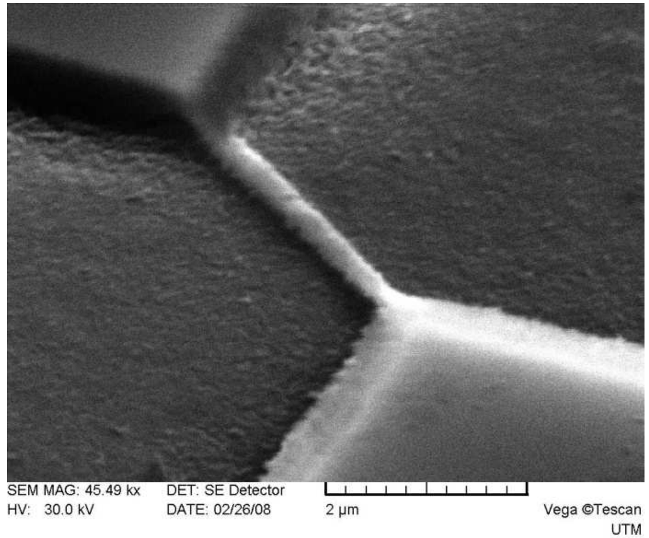


Applied Physics Letters, Vol. 86, 174102 (2005).

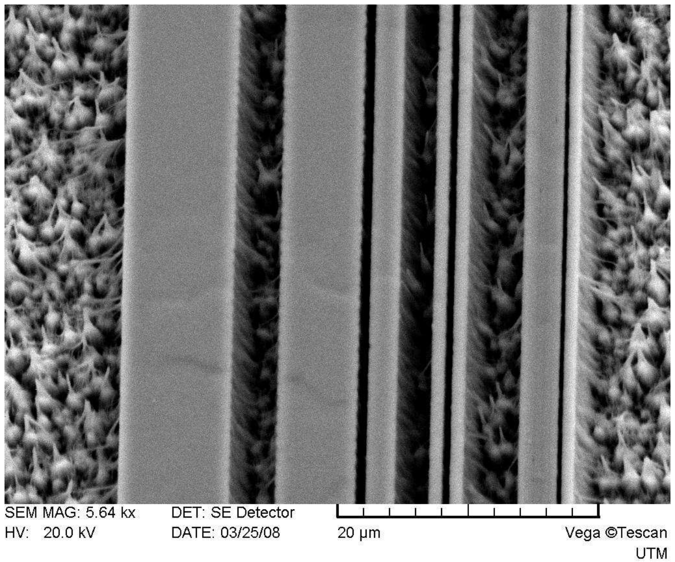
Fabrication of GaN nanowalls and nanowires

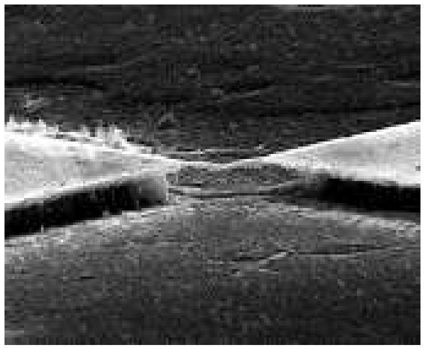
NCMST

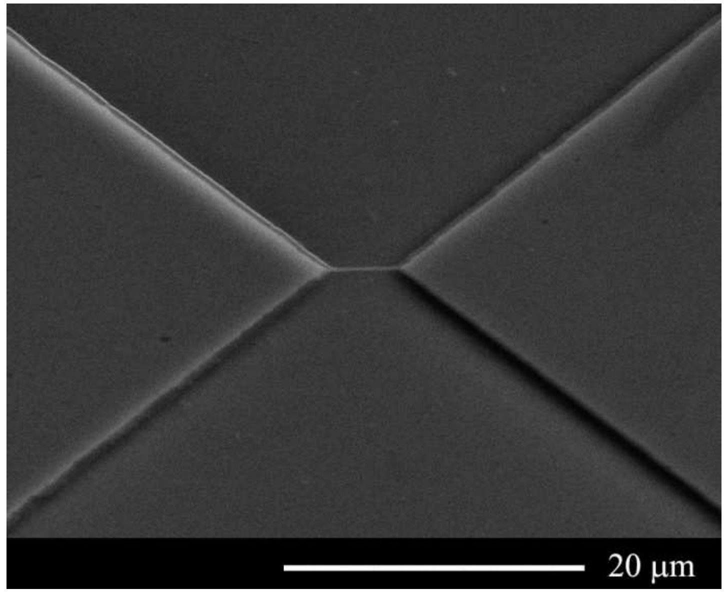




Surface Charge Lithography



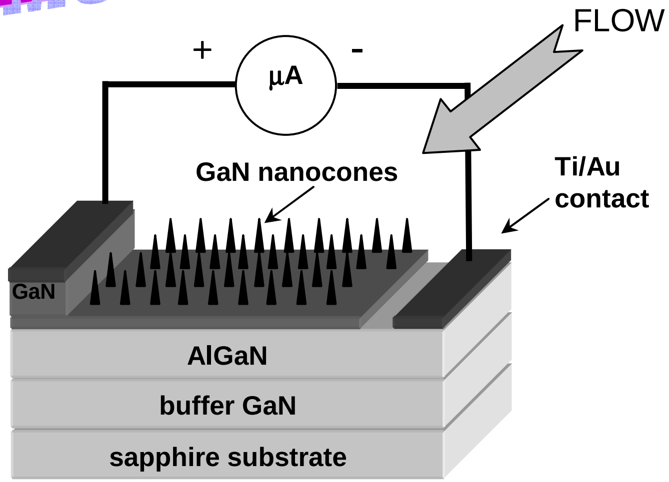




Materials Letters, Vol. 62, p. 4576-4578 (2008).

GaN nanostructure based piezoelectric battery for self powered biosensors applications

NCMST

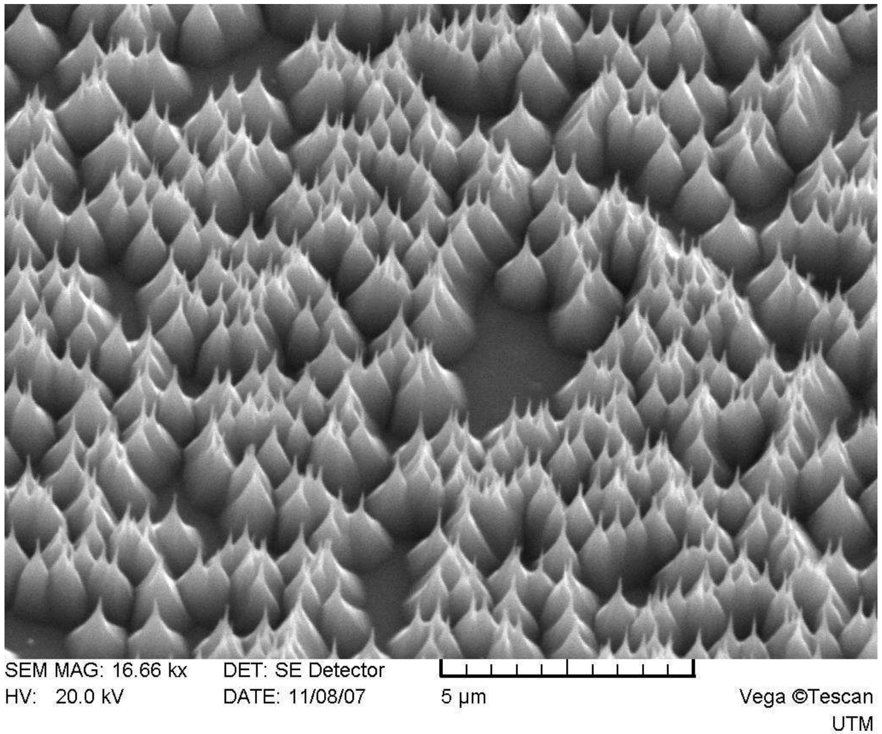


NanoTechWeb.org

http://nanotechweb.org/articles/news/6/5/19/1

GaN Nanopyramids resist radiation

***Applied Physics Letters*, Vol. 90, 161908 (2007).**



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

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

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. 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 (Rusu Emil).**

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

State Program on Nanotechnologies and Nanomaterials

Cluster 3. 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).**

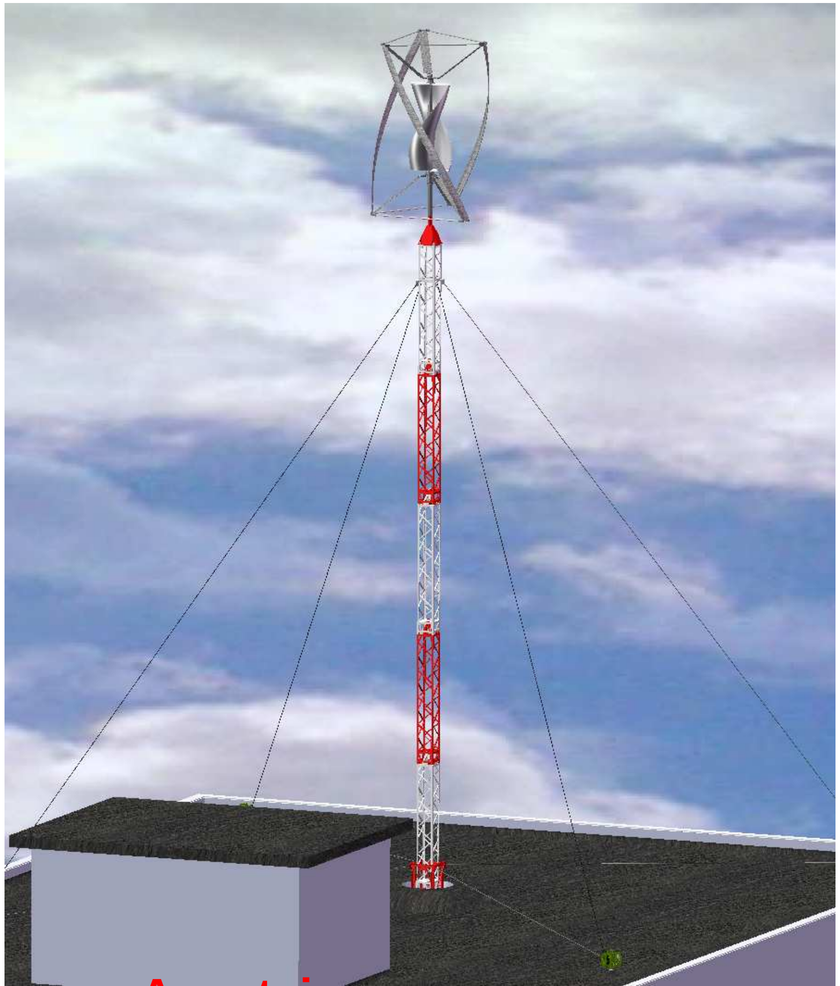
3. **New nanometric multi-layer semiconductor structures for applications in technologies of energy conversion and storage (Igor Evtodiev).**

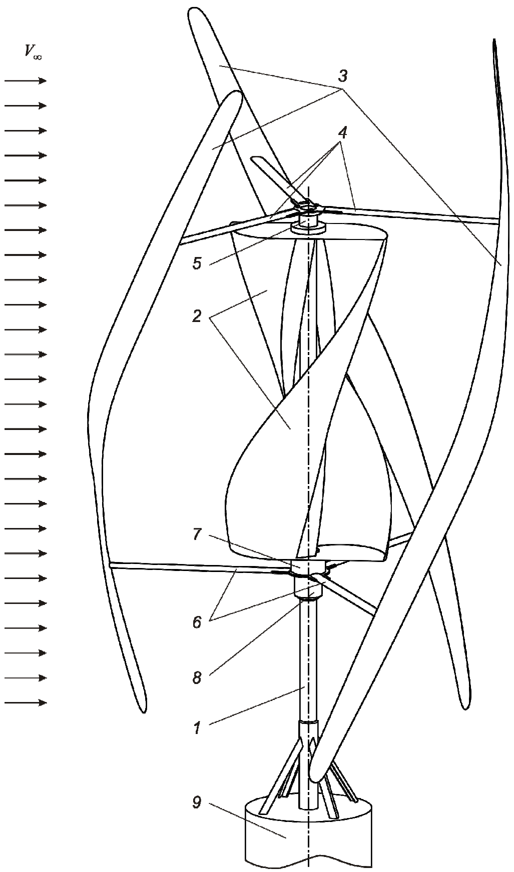
Prototipul industrial microhidrocentralei cu rotor hidrodinamic pentru conversia energiei cinetice a râului în energie electrică şi mecanică

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

Universitatea Tehnică a Moldovei

Turbină de vânt cu pale elicoidale





Avantaje:

-majorarea coeficientului de utilizare a energiei eoliene;

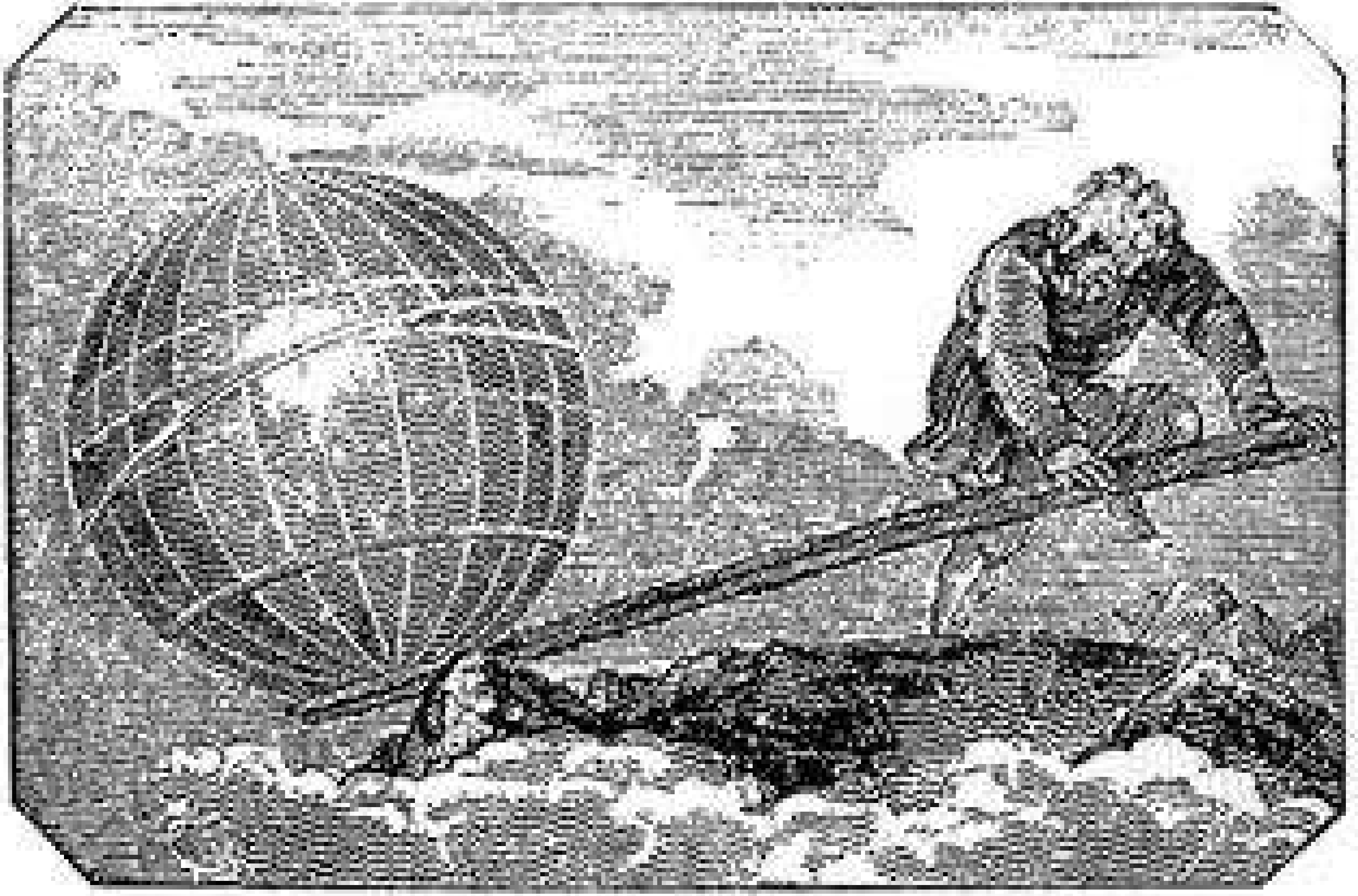
- uniformitatea rotirii organului de lucru;

-zgomot şi vibrații 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.

Knowledge moves the world



Thank you

for your kind attention!