

Micro&Nano Scientific Society



Androula G. Nassiopoulou

President of the Board of Micro&Nano

www.micro-nano.gr

Micro & Nano

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OUTLINE

- ➔ **Beginnings of Micro&Nano**
- ➔ **European landscape**
- ➔ **Greek landscape**
- ➔ **Micro&Nano at present**
- ➔ **Activities**
- ➔ **Future objectives**



MICRO & NANO Scientific Society



➔ **Established in the year 2004**

Continuation of MMN national network
established in 1998 (funded by GSRT)

➔ **Legal Entity: Non-Profit organization
under the Greek law**

➔ **Hosted at IMEL/NCSR Demokritos**



FOUNDING MEMBERS:

a) Organizations

- IMEL/NCSR Demokritos–Athens,
www.imel.demokritos.gr



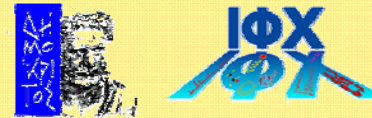
- MRG/IESL/FORTH–Crete
www.iesl.forth.gr



- SSL–University of Patras
<http://athena4.chemeng.upatras.gr>

SSL

- NL-IPC/NCSR Demokritos–Athens
<http://ipc.chem.demokritos.gr>



- IRC-Praxis-Help forward, FORTH
www.help-forward.gr



- ISI, Industrial Systems Institute, Patra
www.isi.gr



GREECE



- ### b) 65 independent scientists from Universities, Research Centers and companies

Today: 130 registered members

www.micro-nano.gr

Main objectives of “MICRO & NANO”

General objective

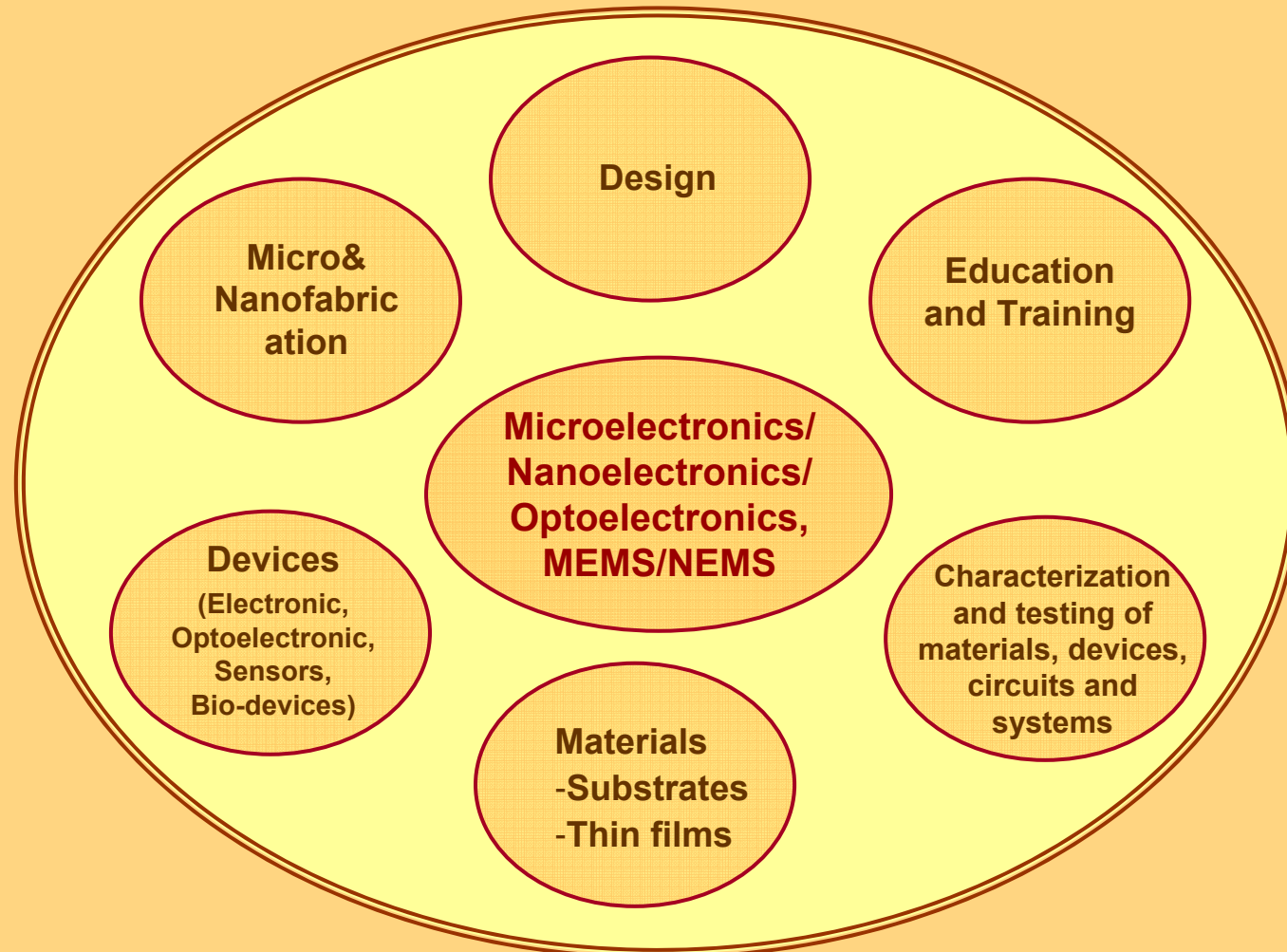
- ➔ To promote the field of Microelectronics/ Nanoelectronics/ Optoelectronics, Nanotechnology and MEMS/NEMS in Greece (Materials, Technologies, Devices, Circuits and Systems)

Specific objectives

- ➔ To gather together scientists from different disciplines and to create synergies and concerted actions for the promotion of the above field
- ➔ To promote collaboration between Academic Institutions, Research Centers and Industry in the above field
- ➔ To create linkages between Greek Scientists and European or International organizations in the field
- ➔ To promote education and training activities in the above field
- ➔ To promote dissemination and spreading of knowledge in the above field



Specific Scientific Fields of “Micro&Nano” members



GENERAL LANDSCAPE

Microelectronics: A foremost driver for social and economic progress worldwide

Nanoelectronics: Will further revolutionize applications

Electronics evolution

Microelectronics



Nanoelectronics

1947.....1965.....1987....
First transistor Moore's forecast Industry goes CMOS



130nm → 90nm → 60nm → 45nm...?

End of roadmap: ~ 5nm technology node?

Why we follow scaling down?

- Faster devices and circuits
- Ultra large scale integration
- Lower power consumption

- ➔ Our technologies are getting smaller
- ➔ Challenges are getting larger

Janez Potocnik,
European Science and Research Commissioner
3rd International Nanotechnology Conference (INC₃),
Brussels, April 2007

European landscape

ENIAC

**European Technology Platform for Nanoelectronics
Report – Vision paper 2004**

AENEAS

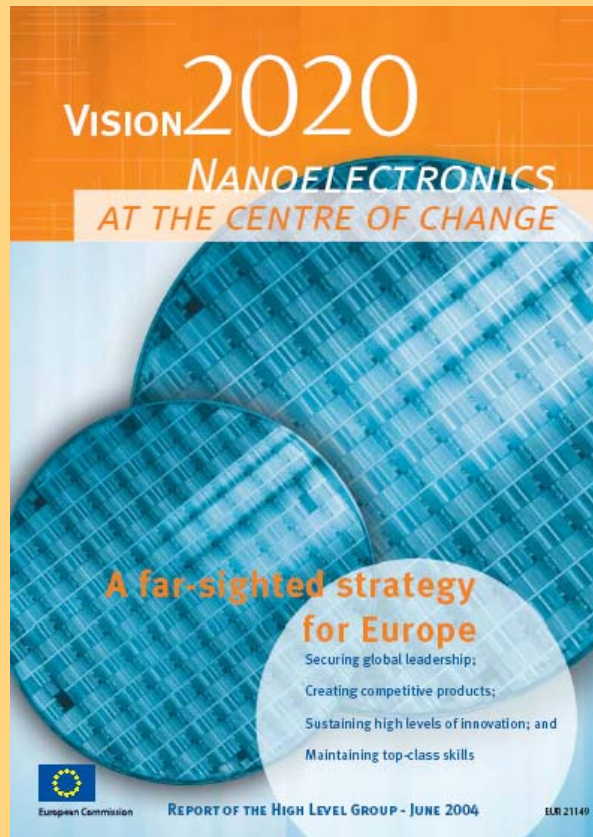
**Legal Entity – Back-bone for the creation of
joint undertaking (2008)**

SiNANO

**European Institute for Nanoelectronics
Legal entity under the French law (2008)**

**(Association of Academic partners,
IMEL – one of the founding members – Established in 2008)**

European Technology platform for Nanoelectronics: ENIAC Vision 2020 (Report: June 2004)



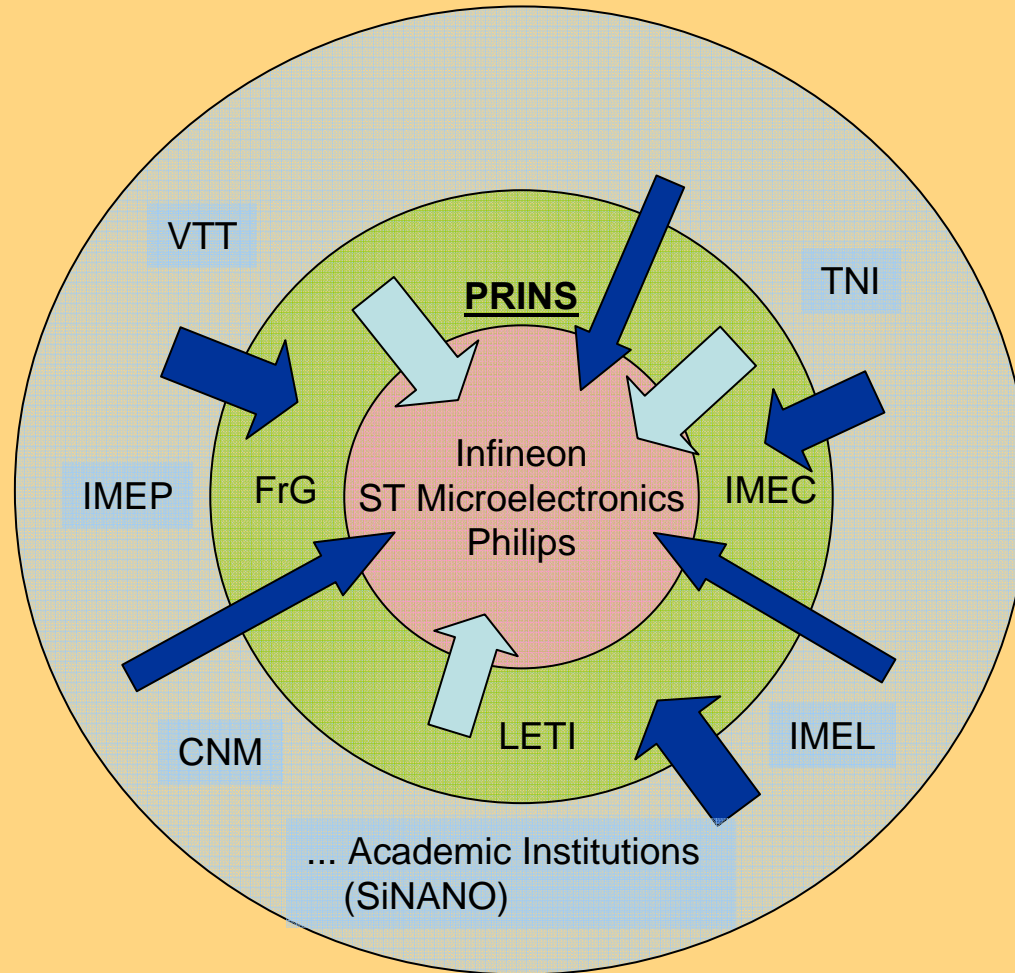
ENIAC: A far-sighted strategy for Europe
Ref. ENIAC Vision paper 2004

**Worldwide annual market for
Electronics ~ € 800 billion⁹**

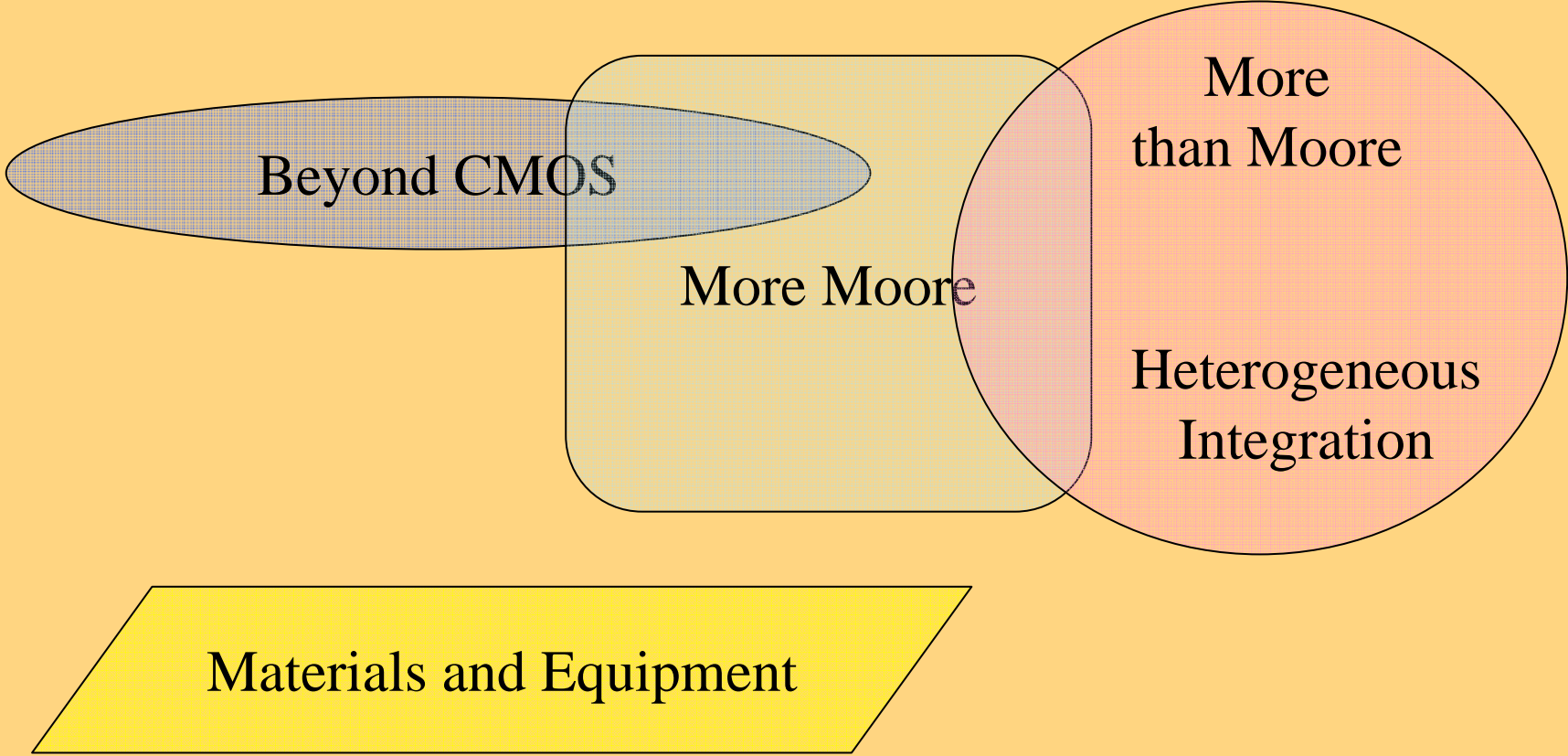
EUROPE

- ➔ ***Leader in Microelectronics***
- ➔ ***Nanoelectronics? How to keep leadership***
 - **Research and Development**
 - **Infrastructures for Research**
 - **Technology platform involving all stakeholders**

Main players in EU - 2004



ENIAC SRA



Technology evolution – Research fields

More Moore...

- Novel effects in ultra small devices
- Novel device architectures, circuit design
- New materials

Beyond CMOS

- Novel logic devices (1D devices, RTD, SETs, molecular devices, spin transistors)
- Novel memory devices (nanofloating gate, phase change memory devices etc.)

More than Moore...

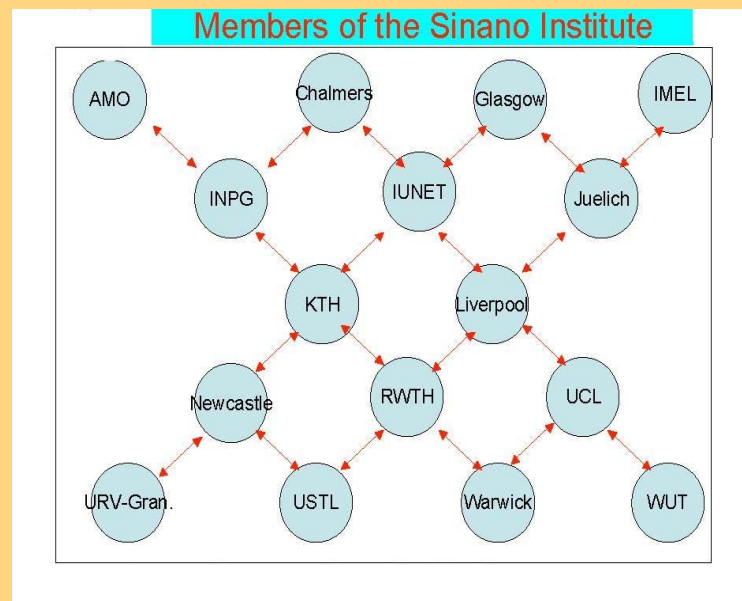
- System on-a-chip (SoC)
- System in-package (SiP)

SiNANO: European Institute for Nanoelectronics

- Legal entity under French the law
- Established in 2008

Founding members: 16 academic institutions with a total of 640 researchers

IMEL ➔ One of the 16 founding members



Organizational structure of SiNANO

- **Director and Board of Management**
- **General assembly**

Main objective: Promote research in the field of Si Nanoelectronics, create linkages and synergies between academic, research organizations and industry, act as a link between the academic community and EU



Micro&Nano:



- ➔ **2004: Establishment as a legal entity**
- ➔ **It emerged from the MMN Network (established in 1998)**



Present Board of Management

- ➔ **A. G. Nassiopoulou, President of the Board, IMEL/NCSR Demokritos**
- ➔ **A. Georgakilas, Vice President, University of Crete and Forth/Crete**
- ➔ **S. Kennou, Secretary, University of Patras**
- ➔ **V. Tsakalos, Treasurer, PRAXI/Help-Forward**
- ➔ **D. Tsoukalas, Member, IMEL/NCSR Demokritos, NTUA**
- ➔ **Ch. Dimitriadis, Member, Aristotle University of Thessaloniki**
- ➔ **E. Iliopoulos, Member, University of Crete and FORTH/Crete**

“MICRO & NANO”

Objectives

- To promote the field of Micro&Nnao at National level
- To create synergies between its members, as well as between Micro&Nano Scientific Society and other Organizations and Scientific Societies in similar fields in Greece and abroad
- To promote the collaboration and create synergies between academic partners and industry (Hellenic-SIA, mi-cluster)

Activities of “MICRO & NANO”

2004 - 2009

- ➔ Information of its members through a mailing list
- ➔ Micro&Nano International Conference
2000, 2004, 2007
Proceeding published by:
World Scientific 2000, IOP 2004, Physica Status Solidi 2007
- ➔ Workshops, Training activities
- ➔ Links with European Association, H-SIA, mi-cluster etc

Future

- Conferences (Micro&Nano 2010 etc
- Workshops
- Newsletter
- Databases with: Research labs in the field, PhD students, Open positions

IMEL / NCSR "Demokritos"



- One of the 8 Institutes of the National Center for Scientific Research (NCSR) "Demokritos"
- It started its activities in 1985
- Today established as the National Center of Excellence in Micro- Nanoelectronics, Micro and nanofabrication and MEMS/NEMS
- Established as a regional pole of Excellence in Nano-Systems and Bio-Systems (EU funding through the REGPOT program)
- Member of SiNANO



Main objectives

- Long-term research. Development of fundamental knowledge.
- Development of novel technologies, processes and high added-value technology products.
- Education and training activities.
- Services in advanced technologies and transfer of technology to the industry.



IMEL's Infrastructure



Full capability in silicon processing, in micro and nanofabrication, characterization and testing, as well as in design, modeling and simulation of materials, structures, devices, circuits and systems.

Processing

- Silicon processing laboratory
- Processing equipment for MEMS/NEMS
- Unique e-beam lithography system (to be purchased)

Characterization of sensors and MEMS/NEMS

- Electrical
- Optical
- Morphological, structural
- Testing of devices and circuits

Modeling & simulation software

Clean room of 500 m²



IMEL/NCSR “Demokritos”



Research Activities

A. MICRO & NANOFABRICATION

- Lithographic Polymers and Processes
- Plasma Processing and Simulation for Micro and Nano Patterning
- Front-end Processes for Micro and Nanodevices
- Thin Films by Chemical Vapor Deposition (CVD)

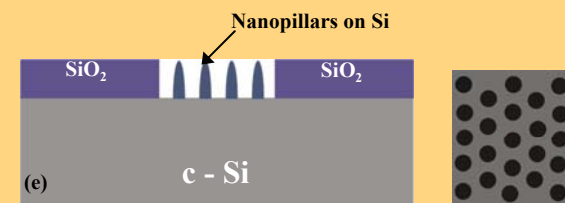
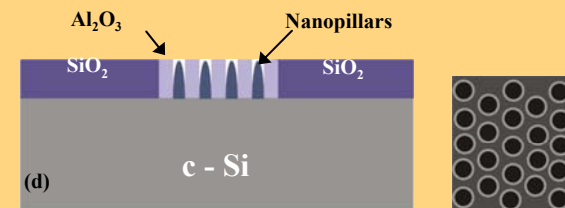
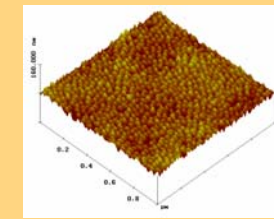
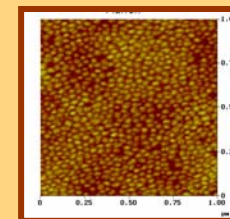
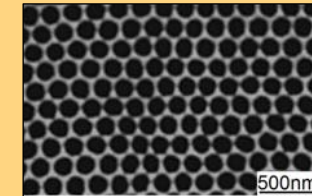
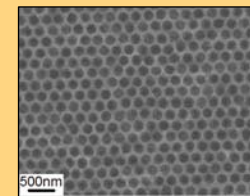
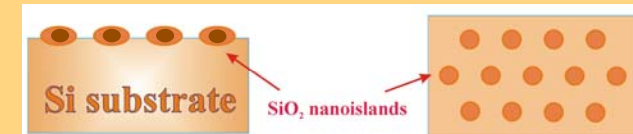
B. NANOSTRUCTURES & NANOELECTRONIC DEVICES

- Semiconductor Nanostructures Science, Technology and Applications
- Silicon Nanocrystal Memories
- Molecular Materials as Components of Electronic Devices

C. SENSORS AND MEMS/NEMS

- Silicon Micromachined Sensors and MEMS/NEMS
- Bio-microsystems
- Energy harvesting materials and devices
- Thin Film Devices for Large Area Electronics
- Circuits and Devices for Optoelectronic Interconnections

Examples of EU projects: ANNA, Micro2DNA, NANOSIL, PYTHIA, SiNANO, REGPOT



Microelectronics Research Group (MRG) of IESL, FORTH at Heraklion, Crete

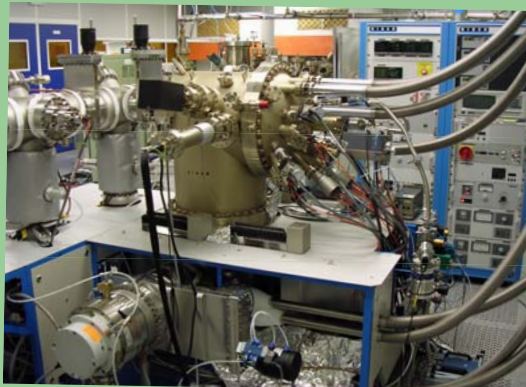


UoC & FORTH

200m² class-1000 Clean Rooms

Molecular Beam Epitaxy

III-V
GaAs
GaN



SiC

Device Processing



RIE
PECVD

DUV lithography
E-beam lithography

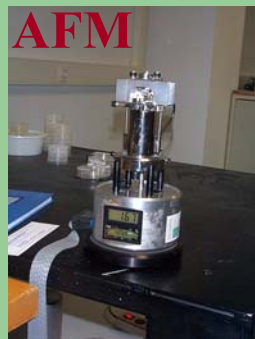


E-beam
Evaporator

Material Characterization



HR-XRD



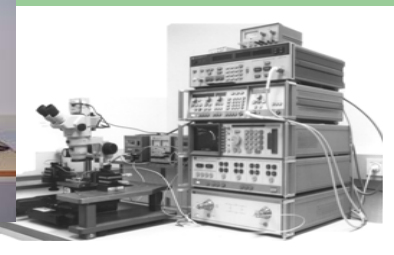
AFM

PL, μ -PL,
ultrafast, etc.
DLTS
Hall
FE-SEM

Device Characterization



I-V, C-V
L-I



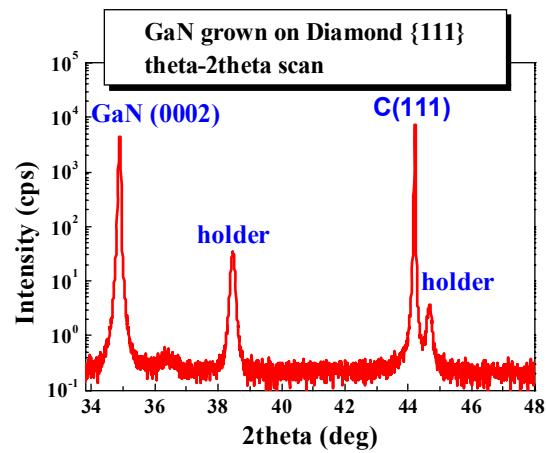
RF ~20GHz

Research activities at MRG-IESL-FORTH

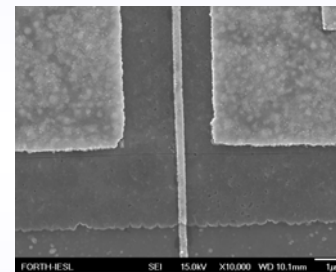
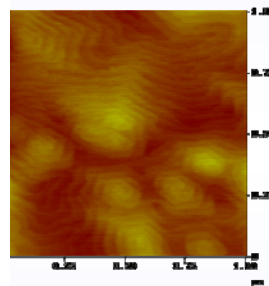


- Advanced heterostructure & nanostructure semiconductor materials
- Novel optoelectronic and microwave devices and sensors

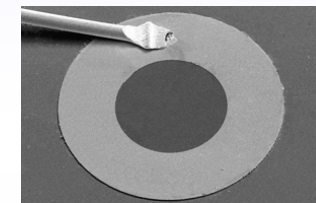
III-nitrides MBE growth



GaN and SiC electronic devices

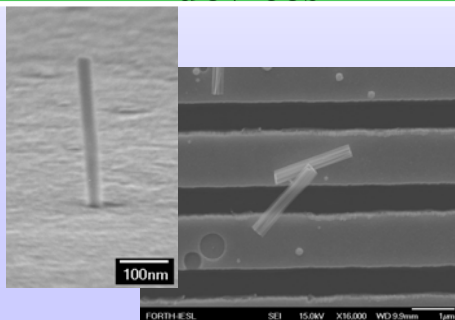


Polariton LEDs and Lasers

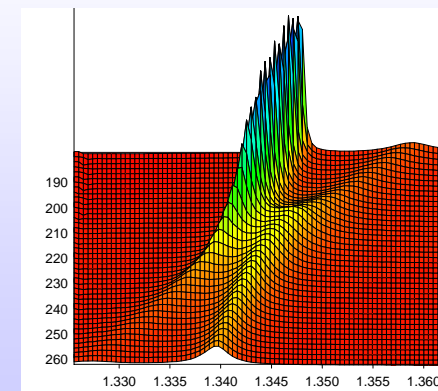
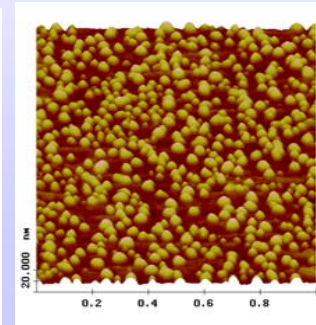
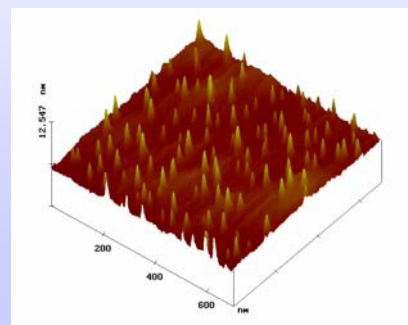


S. Tsintzos, Nature 2008

Nanowires growth and devices



Quantum Dots & single photon sources



SURFACE SCIENCE LABORATORY

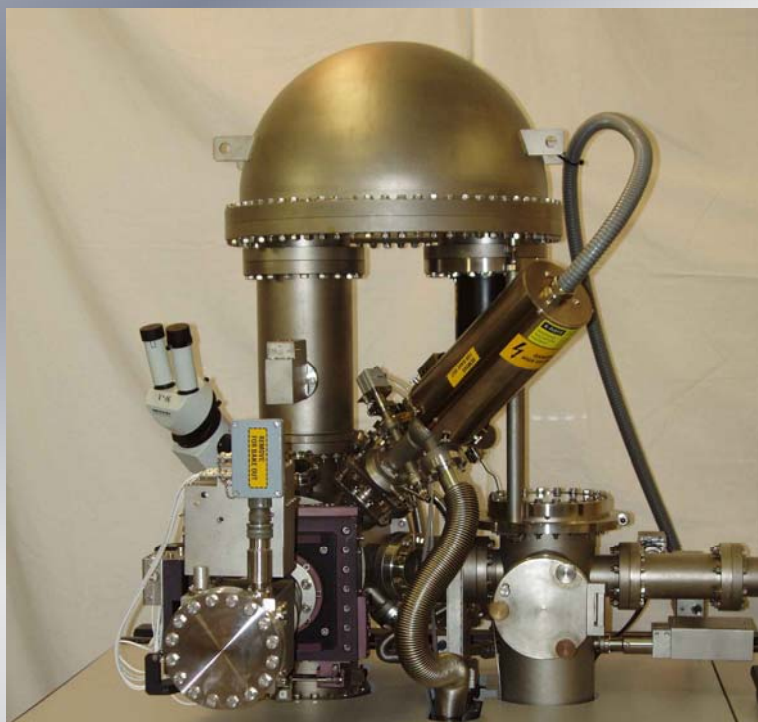
S S L

Department of Chemical Engineering, Univ. of Patras

Website : <http://athena4.chemeng.upatras.gr>

Infrastructure

1. An ultra-high-vacuum (UHV) chamber equipped with a versatile combination (unique in Greece) of several surface sensitive techniques (XPS, UPS, AES, ISS, LEED, TPD and WF measurement) for thorough surface and interface characterization of any solid material, especially in the form of thin films, either clean or interacting with various gases over a wide range of temperatures (- 100 to 800 centigrade)



2. A fully automated MAX200 Surface Analysis System (XPS, XAES, ISS), mainly dedicated to surface analysis services (under accreditation according to ISO 17025)

Website : <http://athena4.chemeng.upatras.gr>

Main Objectives

- ❖ Conducting high quality fundamental and applied research.
- ❖ Development of human potential through educational and training activities (undergraduate/graduate students and post-doctorates).
- ❖ Surface analysis services to academic/research institutions and the industry.

Research activities

➤ *Surface Science aspects of heterogeneous catalysis*

Model experiments on single crystals

Realistic model catalysts

➤ *Surface and interface properties of electronic materials*

Metal/semiconductor interface formation

Metallic and bimetallic thin films on oxides

Interfaces for organic electronics

Carbon based materials

➤ *Spectroscopic characterization of special materials*

Chemically modified polymers, nanocomposites, biomaterials etc.

Operating Framework

PRAXI / HELP-FORWARD Network belongs in the Central Administration of FORTH and operates in cooperation with SEV and FING

Mission

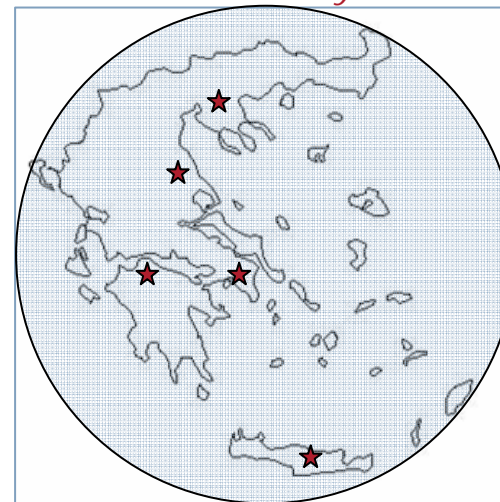
To make Greek enterprises and laboratories more competitive via:

- *the linkage between research - industry – investment funds*
- *the promotion of innovation & entrepreneurship*
- *the transnational cooperation*

Networks & Assignments

- *Member of the Enterprise Europe Network, the largest business support & technology transfer network in Europe*
- *National Contact Point in Greece for FP7 (NMP, Space, Security, Transport, INCO, Legal & Financial)*
- *FORTH's Industry Liaison Office*
- *Mentor of public organisations worldwide*

*Offices in 5 cities in Greece
(at the premises of regional associations of Commerce and Industry and FORTH)*



www.help-forward.gr

Services to enterprises and labs:

- *Assistance for best use of national and European funding programs*
- *commercial exploitation of research results*
- *marketing of Greek technologies abroad and mediation with foreign partners*
- *identification of specialized technological solutions*

Post-graduate educational programs in Micro & Nano

M.Sc and PhD degrees in Microelectronics,

*Department of Informatics, University of Athens,
IMEL/NCSR Demokritos*

M.Sc. degree in "Microsystems and Nanoelectronic

*Devices" National Technical University of Athens, in
collaboration with IMEL provides support in laboratory training
and in specialized courses.*

M.Sc. and PhD degrees in "Optoelectronics"

University of Crete

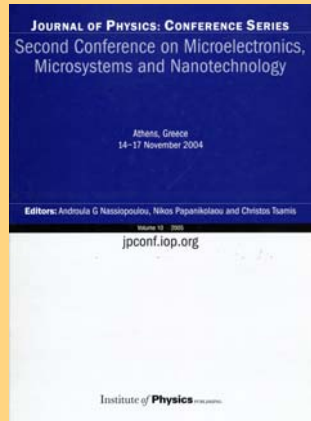
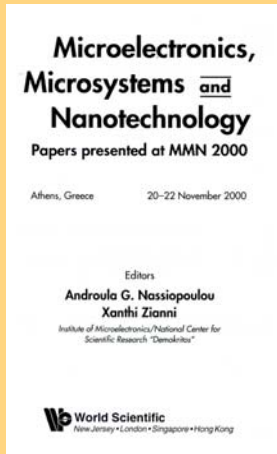
Other activities of Micro&Nano members

- **Electrical Characterization of devices** - NTUA, University of Thessaloniki, University of Athens, University of Patras
- **VLSI design** – University of Athens, Patras, NTUA, Thessaloniki, Xanthi
- **Photovoltaics** - IMEL, University of Xanthi, University of Ioannina
- **Electron Microscopy** – University of Thessaloniki, NCSR D, others
- **Materials** – IMS-NCSR D, FORTH, IMEL, University of Ioannina, University of Patras, Athens (NTUA, UoA), University of Thessaloniki etc
- **Surface Spectroscopies** – University of Patras, University of Ioannina
- **Electronics** (design, realization, testing in different Universities and TEI)
- **Others**

CONCLUSIONS

NEED FOR:

- ➔ **A National program in Nanoelectronics and MEMS/NEMS**
- ➔ **Support of National Facilities and Infrastructure**



Thank you for your attention

