

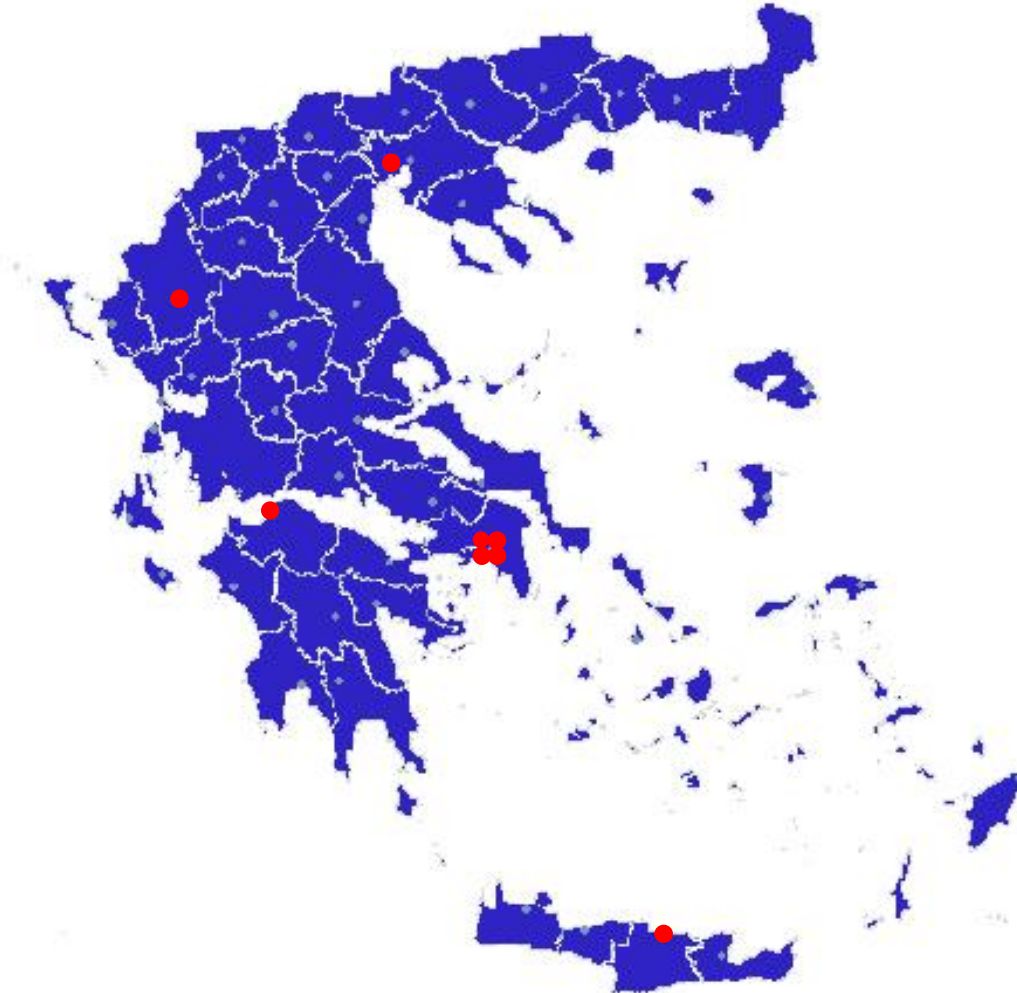
# Overview of MicroNanoBioSystems in Greece

*Panayiota Petrou*

*Institute of Radioisotopes and Radiodiagnostic Products*

*NCSR 'Demokritos'*

# MicroNanoBioSystems in Greece



MNBS 2012, Athens May 3-4, 2012

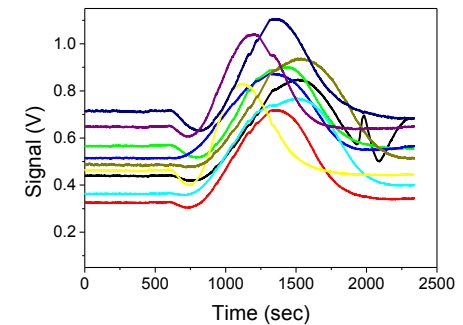
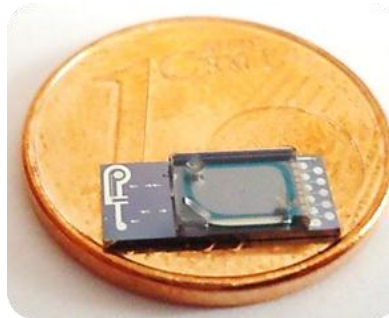
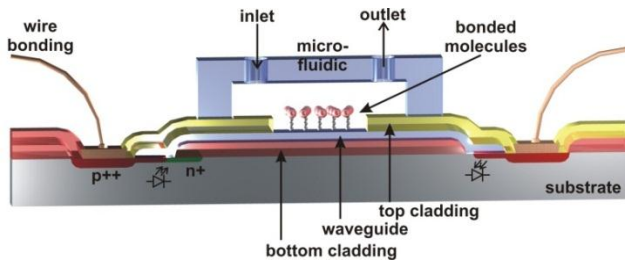
# NCSR 'Demokritos' activities

## Monolithically Integrated Optical Biosensor arrays for label and label-free detection of biomolecular Interactions

### WHO-ROLE

Integrated Optics lab, **IMEL**: Silicon Transducer development

Immunoassays-Immunosensors lab, **IRRP**: Protocols & Evaluation



### APPLICATIONS:

- For cardiac and cancer markers
- For DNA mutations to detect predisposition to hereditary diseases
- Food & environment (future)

# NCSR 'Demokritos' activities

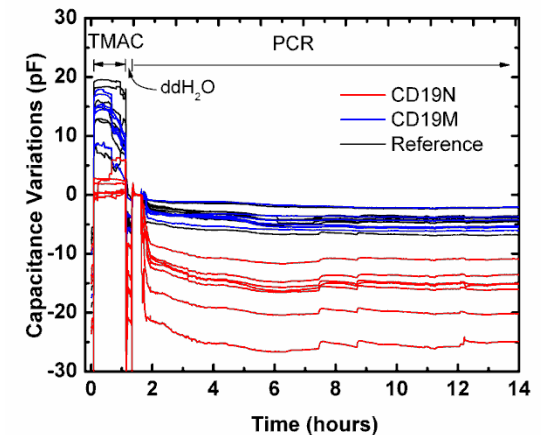
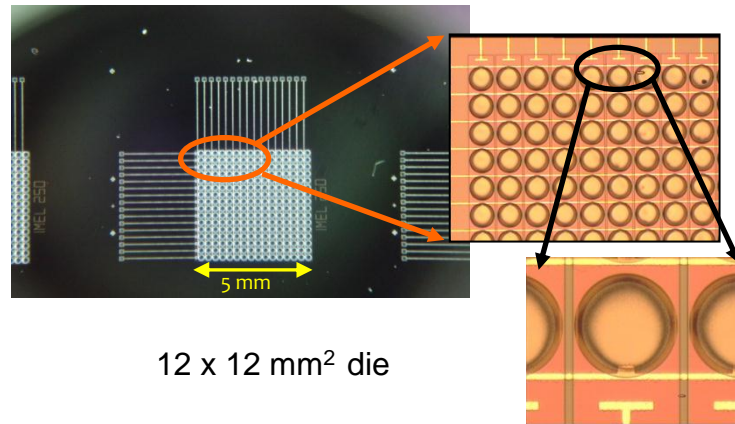
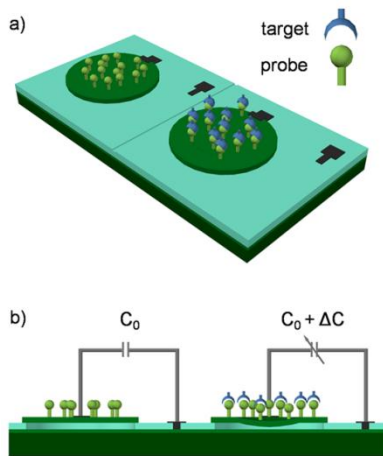
## Micromechanical Capacitive Biosensor

### WHO-ROLE

Mechanical and Chemical sensors lab, **IMEL**: Silicon sensor development

### Operation

Ultrathin Si membrane - Probe target interactions give rise to changes of membrane surface stress and membrane deflection which is recorded as a change in device capacitance



### APPLICATIONS:

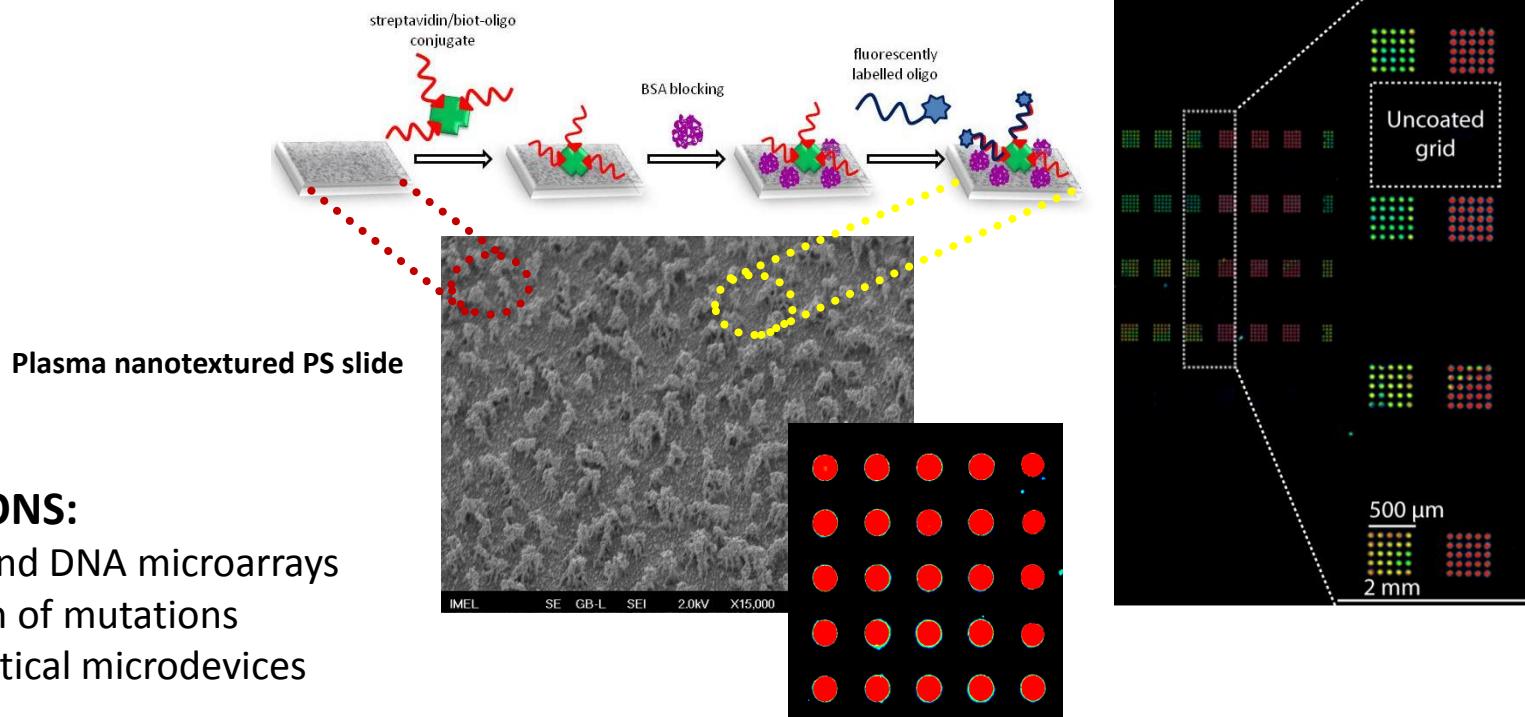
- Tested in  $\beta$ -thalassemia mutations
- Future testing in KRAS gene mutations and lead presence detection

# NCSR 'Demokritos' activities

**Highly dense, intense and uniform protein and DNA arrays on glass and polymeric substrates**

## WHO-ROLE

Plasma Technology and Microfluidics Lab, **IMEL** : substrate physical and chemical modification  
Immunoassays-Immunosensors lab, **IRRP** : biomolecule immobilization and array evaluation



## APPLICATIONS:

- Protein and DNA microarrays
- Detection of mutations
- Bio-analytical microdevices

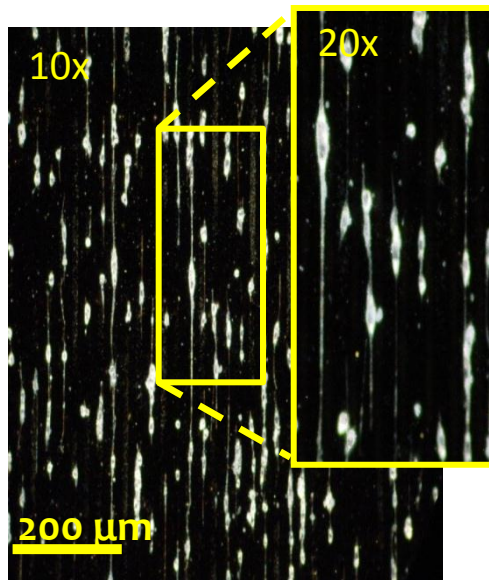
# NCSR 'Demokritos' activities

## Cell patterning on non-fouling surfaces prepared by photolithography

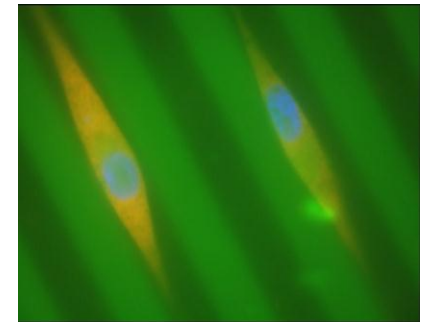
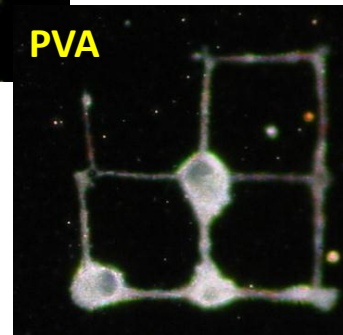
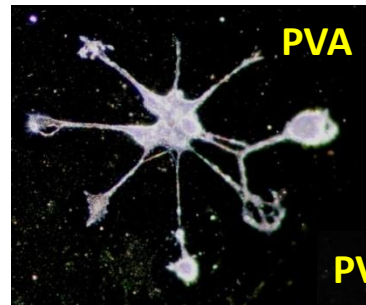
### WHO-ROLE

Photolithographic processes and materials lab, **IMEL** : photolithographic procedure based on poly(vinyl alcohol) film to create patterns with non-fouling properties

Immunoassays-Immunosensors lab, **IRRP**: cell culture onto the patterned surfaces and evaluation of cell viability



25 μm wide silicon lines

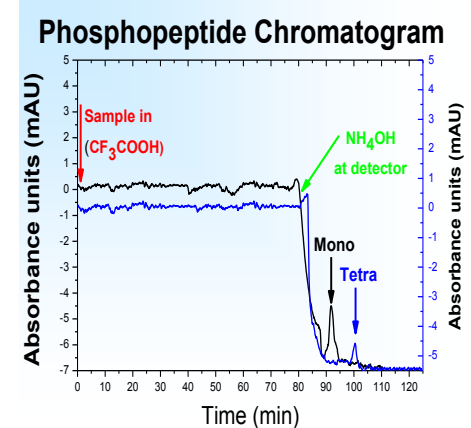
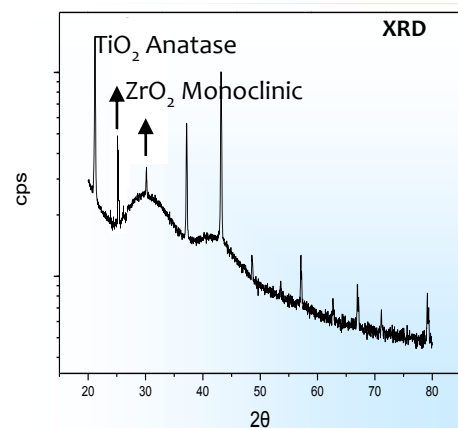
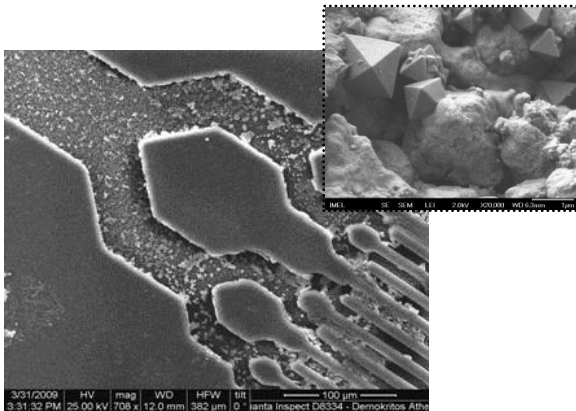


# NCSR 'Demokritos' activities

## TiO<sub>2</sub>-ZrO<sub>2</sub> affinity microcolumns for on-chip enrichment and separation of phosphopeptides

### WHO-ROLE

Plasma Technology and Microfluidics Lab, **IMEL**: microcolumn development  
Biomedical Research Foundation, **Academy of Athens**: MALDI MS detection



### APPLICATIONS:

- Phosphoproteomics: analysis of phosphoproteins
- alternative to extraction tips

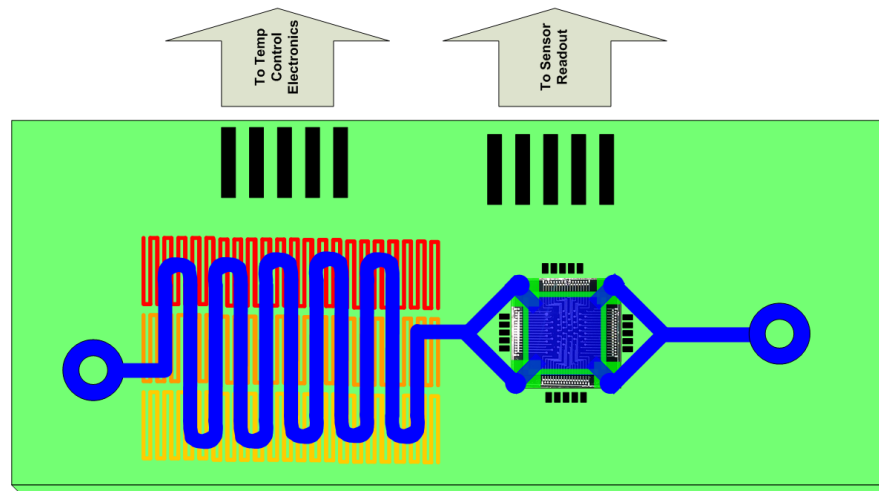
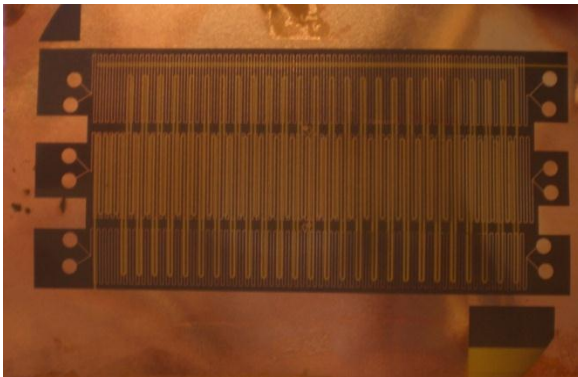
# NCSR 'Demokritos' activities

## Continuous-flow $\mu$ -PCR on polymeric substrates and LoC for disease diagnosis

### WHO-ROLE

Plasma Technology and Microfluidics Lab, **IMEL**:  $\mu$ PCR and biosensor development

**Biomedical Research Foundation, Academy of Athens**: protocols for DNA detection and off-chip PCR evaluation



### APPLICATIONS:

- Disease diagnosis
- Food monitoring (future)

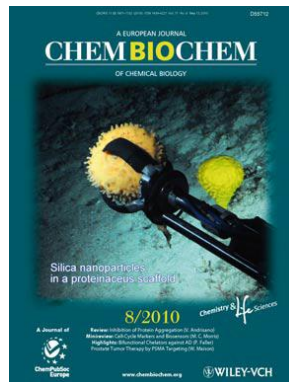
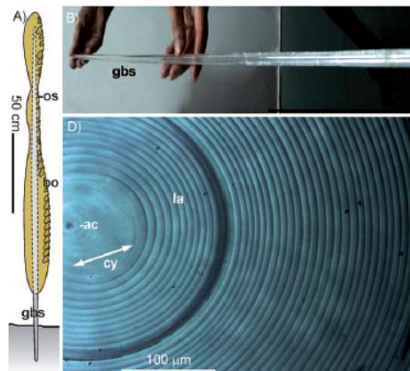
# NCSR 'Demokritos' activities

## Biom mineralization: Understanding of basic mechanisms for the design of novel strategies in nanobiotechnology

(BIOMINTEC: ITN-GA-2008-215507)

### WHO-ROLE

Structural and Supramolecular Chemistry:  
Structure elucidation of proteins involved in biom mineralization in sponges: Siliceous sponges can form their skeleton through an enzyme (silicatein)-driven reaction



### APPLICATIONS:

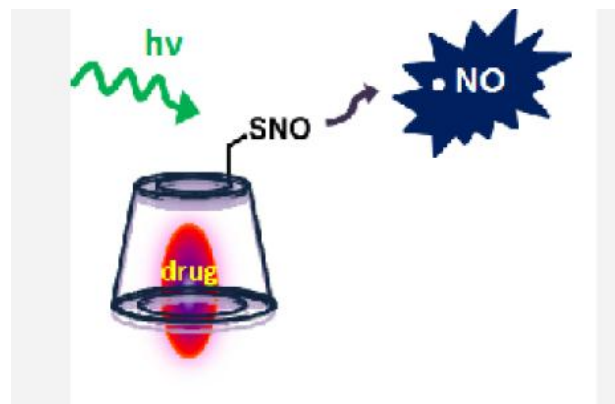
- Bio-inspired chemically-derived inorganic-organic composite materials and routes

## Novel multifunctional cyclodextrin-based nanocarriers for drug encapsulation and delivery as a strategy to overcome current therapeutic drawbacks

(CYCLON: ITN 2008-2379627)

### WHO-ROLE

Supramolecular Chemistry: synthesis and functionality of smart cyclodextrins



### APPLICATIONS:

- Bimodal photoactivable drug delivery systems

# National Hellenic Research Foundation Theoretical and Physical Chemistry Institute

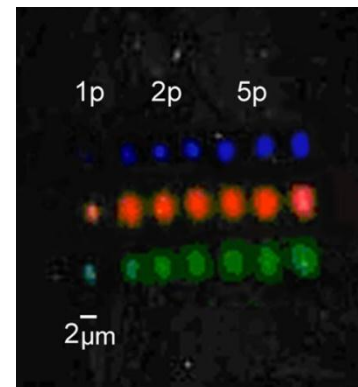
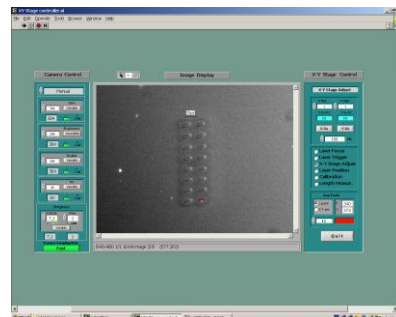
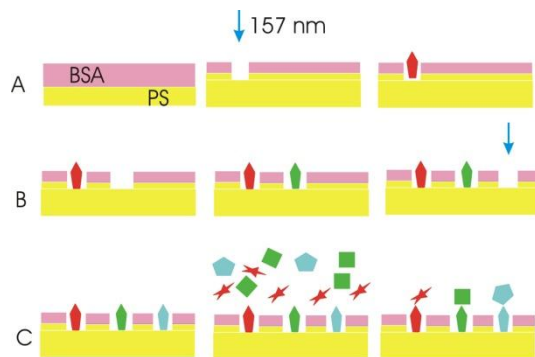
## Protein immobilization and detection on vacuum ultraviolet laser processed surfaces

### WHO-ROLE

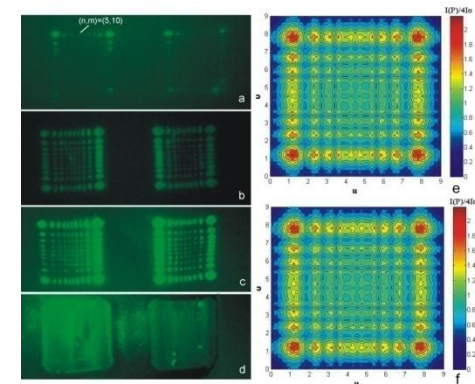
Photonic for Nanoapplications lab, **NHRF**: Laser micro/nano fabrication

Immunoassays-Immunosensors lab, **IRRP, NCSR Demokritos**: Biomolecules-biomarkers

Automatic bio-array laser patterning system



Bio-array pattern



sensitivity~0.1 pJ

### APPLICATIONS:

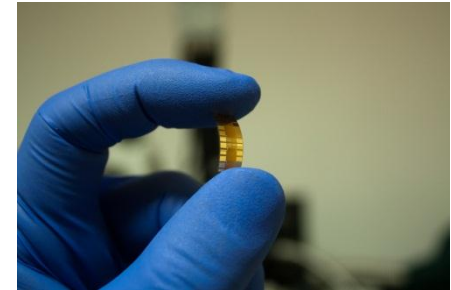
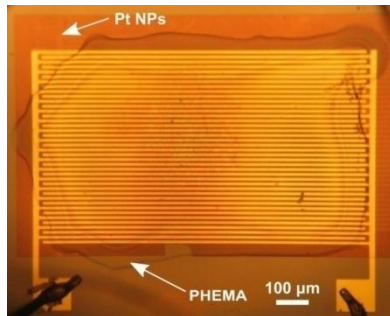
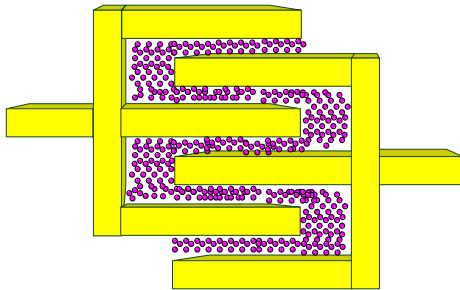
- High density writing

# National Technical University Athens (NTUA)

## Nanoparticle assemblies within Interdigitated Electrodes for monitoring biomolecular interactions

### WHO-ROLE

**Electronic Nanomaterials and Devices Lab**, Dept. of Applied Physics, NTUA: Device fabrication  
**Biomedical Research Foundation of the Academy of Athens**: Protocols & Evaluation



### APPLICATIONS:

- Environment & Food
- DNA mutations (in progress)

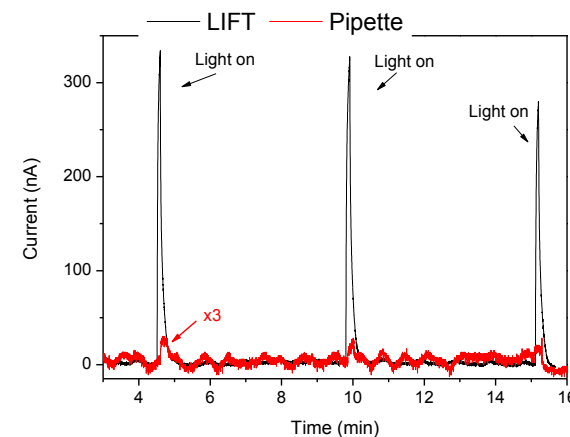
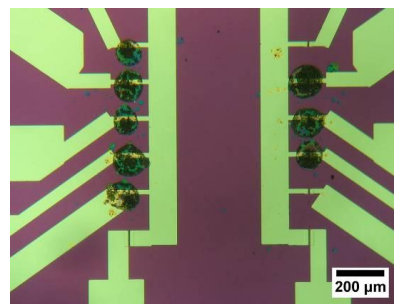
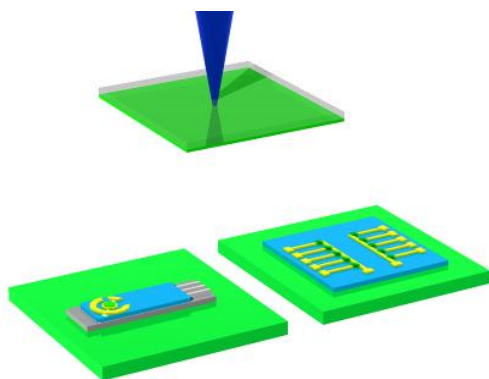
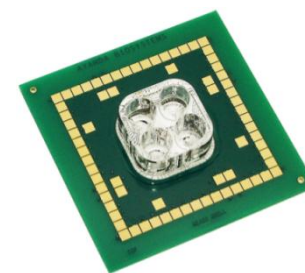
# National Technical University Athens (NTUA)

## Electrochemical photosynthetic protein-based biosensors

### WHO-ROLE

**Physics Lab**, NTUA: Laser immobilization of photosynthetic proteins

**BS Lab**: Instrumentation and Characterization



### APPLICATIONS:

- Environmental monitoring (pesticides, herbicides and heavy metals)
- Endocrine Disruptive Compounds
- Agro-food analysis

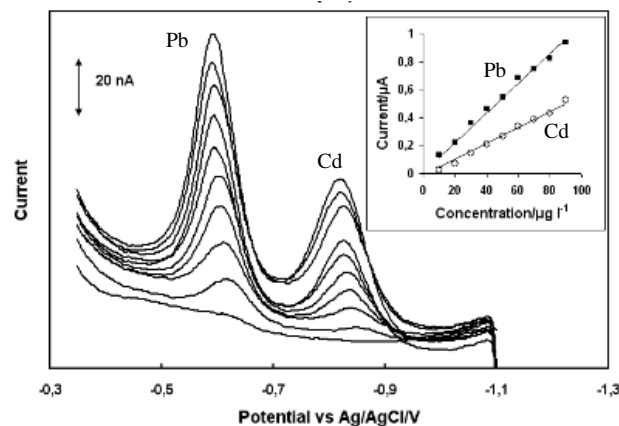
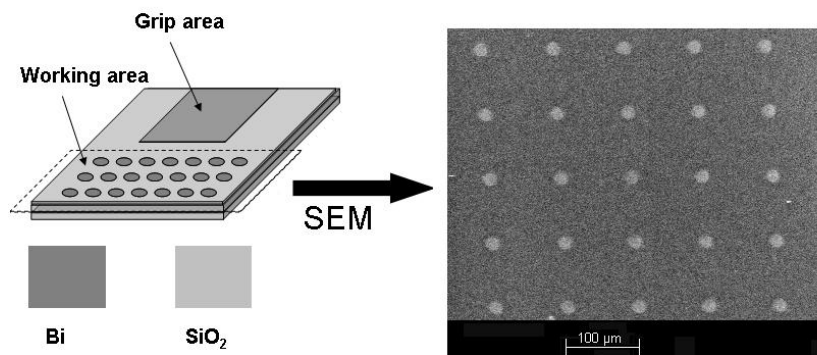
# University of Athens, Department of Chemistry

## Microfabricated electrochemical sensors for heavy metal analysis

### WHO-ROLE

**Analytical Chemistry Lab**, Dept. Chemistry, University of Athens: protocols and evaluation

**IMEL, NCSR Demokritos**: fabrication, characterisation of sensors



### APPLICATIONS:

- Environmental analysis
- On-site pollution screening
- Drinking water quality control

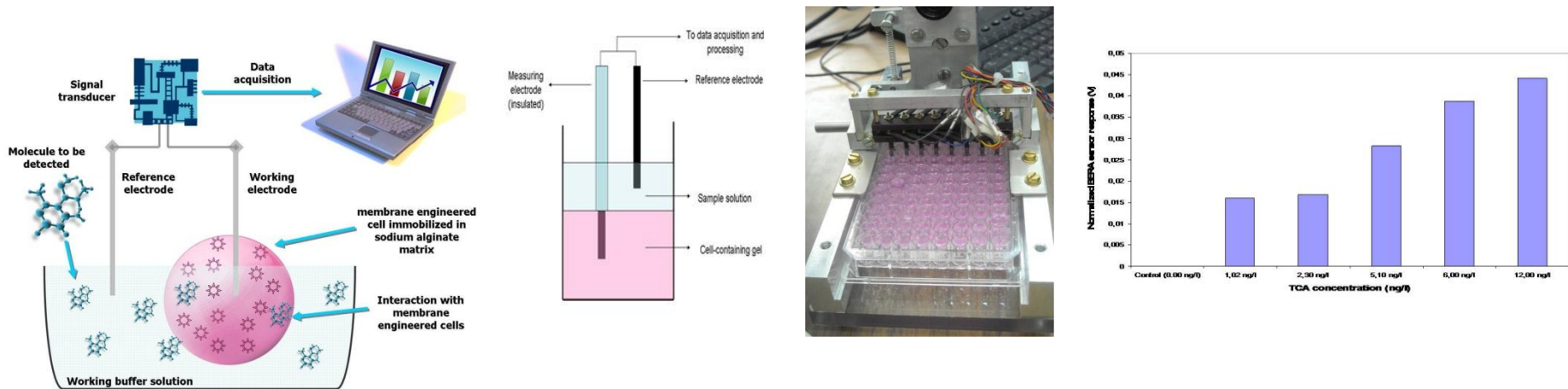
# Agricultural University of Athens (AUA)

## Development of next generation cell-based biosensors

### WHO-ROLE

**Cell & Tissue Culture Lab**, Dept. Agricultural Biotechnology, AUA: Team leader, Novel Biorecognition Elements, Sensor assembly, Protocols & Validation

**Informatics Lab**, Dept. of Science, AUA: Artificial Neural Networks for cell-derived signal interpretation



### APPLICATIONS:

- Medical Diagnostics
- Food safety
- Environmental monitoring

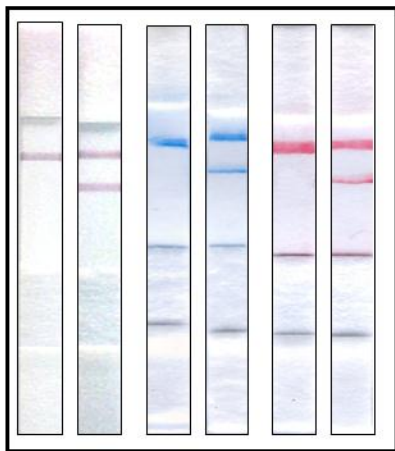
# University of Patras, Department of Chemistry

## TECHNOLOGY FOR ANALYSIS OF NUCLEIC ACIDS & PROTEINS

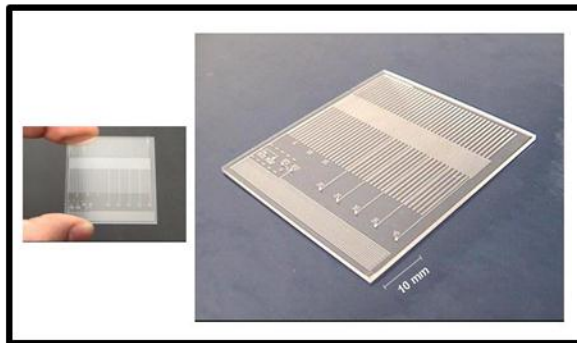
### WHO-ROLE

Analytical Chemistry / Chemical Instrumentation Lab, Dept. Chemistry, UOP

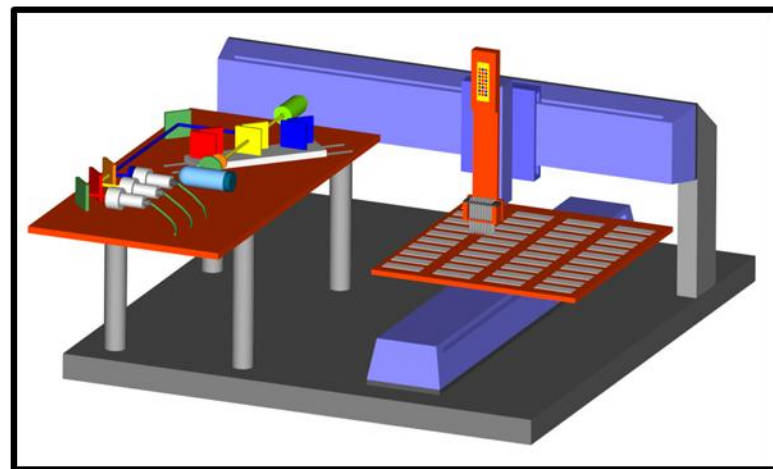
#### Biosensors for DNA Detection by Naked Eye



#### Microfluidic Devices for DNA/RNA Amplification & Detection



#### Home-Built Integrated Microarray Spotter & Scanner



### APPLICATIONS:

- Detection of Single Nucleotide Polymorphisms
- Molecular Diagnosis
- Food control

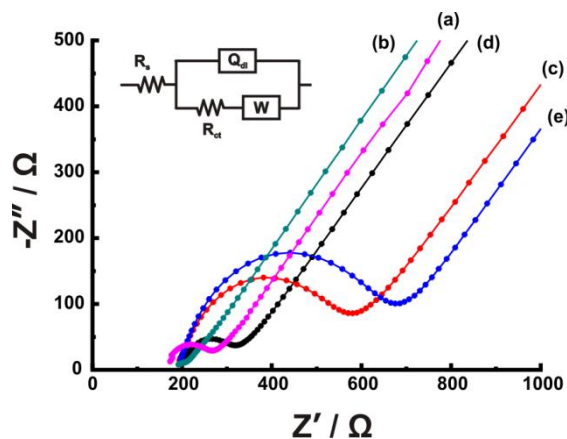
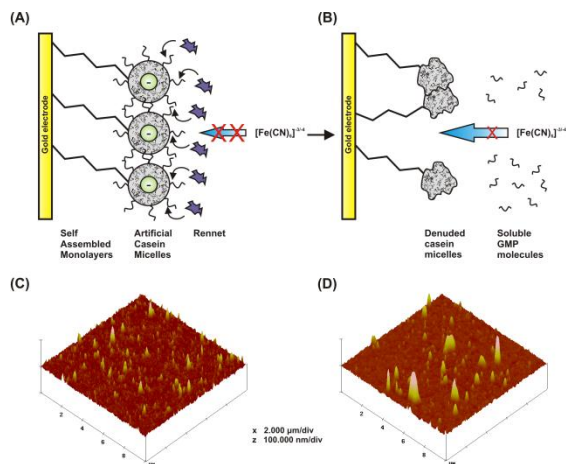
# University of Ioannina

## Laboratory of Chemical Sensors & Biosensors

### Design and Development of Biochemical Capacitors for the monitoring of biomolecular interactions

#### WHO-ROLE

Laboratory of Chemical Sensors and Biosensors, Dept Chemistry, UOI



#### APPLICATIONS:

- Food industry: Determination of the clotting activity of rennet
- Detection of Pathogens
- Cardiac markers
- Public Health (microbiological analysis of drinking water) – in progress

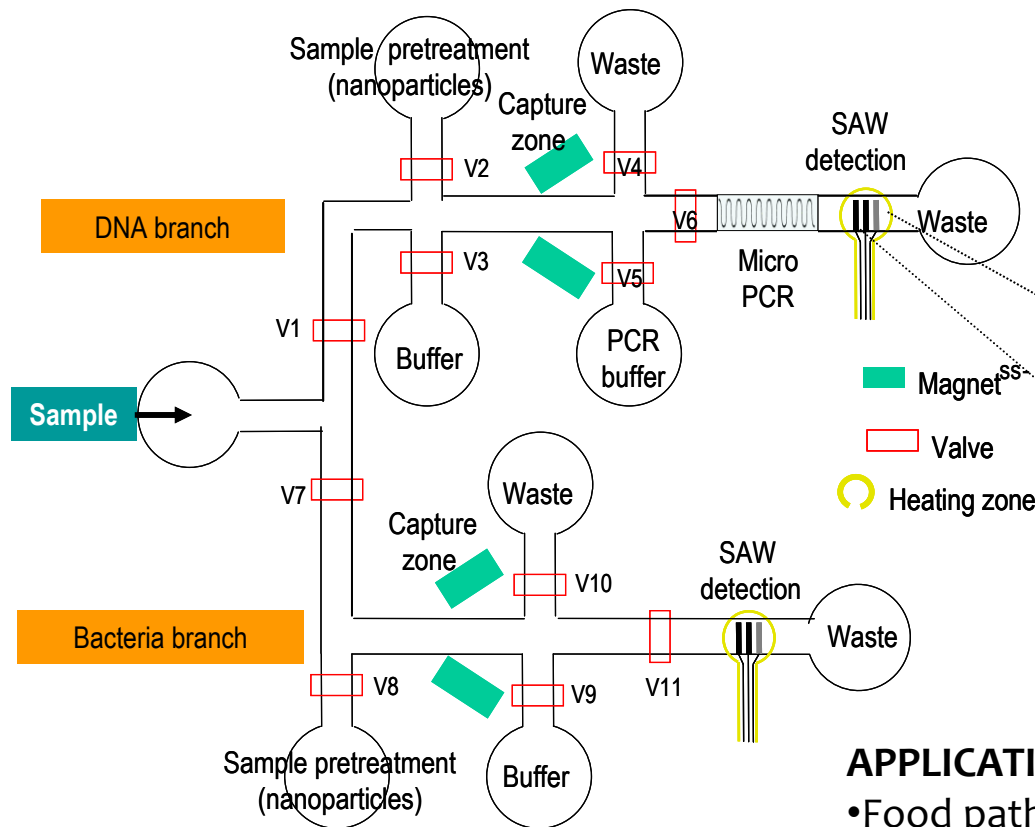
# Institute of Molecular Biology and Biotechnology

## FORTH, Crete

### WHO-ROLE

**Biosensors Lab**, IMBB, FORTH: Development of **acoustic biochips** combined with **molecular assays** sensitive to DNA conformation

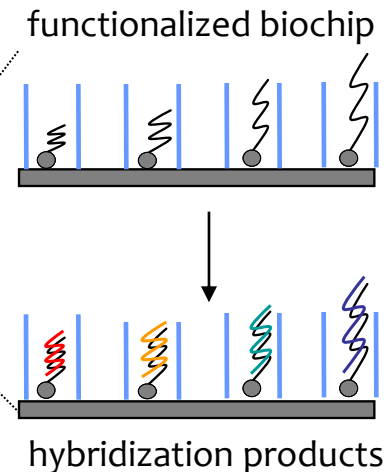
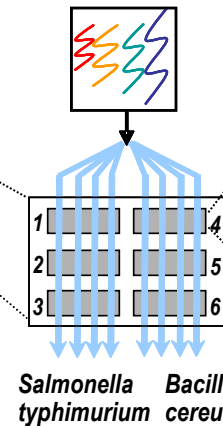
### Integrated platform (Lab-on-chip)



**Sensing element**

**Molecular assay**

PCR targets



**LOVE FOOD project**

### APPLICATIONS:

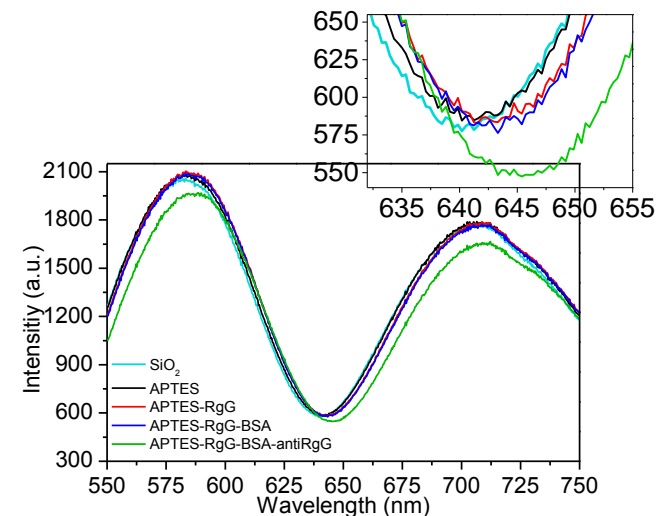
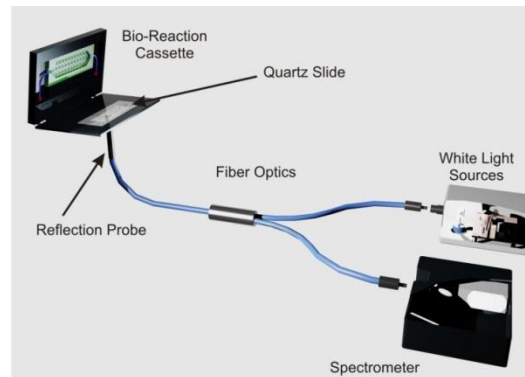
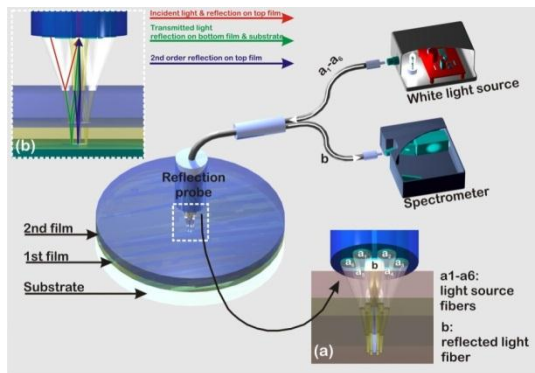
- Food pathogens detection (current)/ GMOs (future)
- Molecular diagnostics (future)

# ThetaMetrisis S.A.

**Miniaturized turn-key photonic solutions for multi-analyte label-free monitoring of bioreactions**

## TECHNOLOGY

White Light Reflectance Spectroscopy - Microfluidics



## APPLICATIONS:

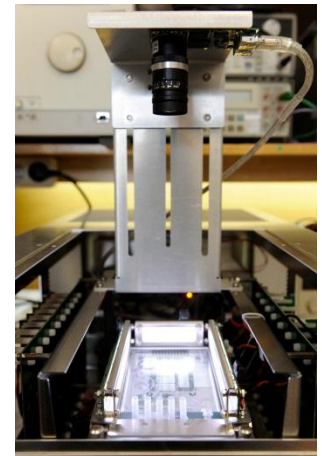
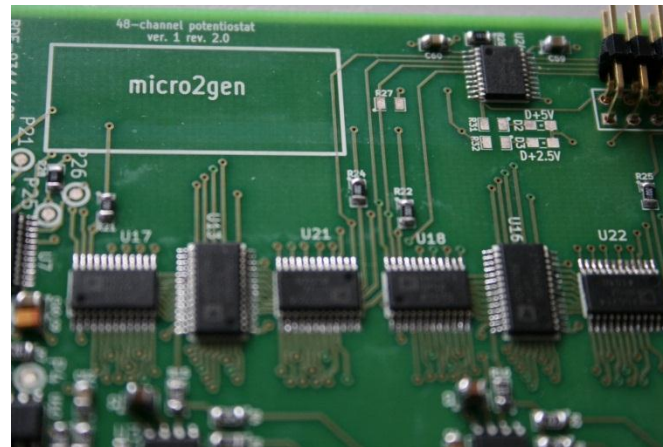
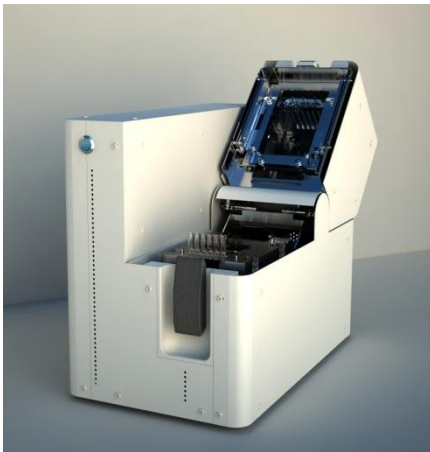
- Proteins
- DNA mutations
- Food & environment (future)

# micro<sup>2</sup>gen Ltd.

## Flexible Instrumentation for Molecular Diagnostics and Rapid-Prototyping Tools

### WHO-ROLE

Reconfigurable electronics and adaptable firmware and software solutions  
Novel control mechanisms for microfluidics solutions



### APPLICATIONS:

- Coeliac Disease (CDMEDICS)
- Cystic Fibrosis, b-Thalassaemia, Cardiology, Pharmacogenomics
- Agriculture and Food (future)

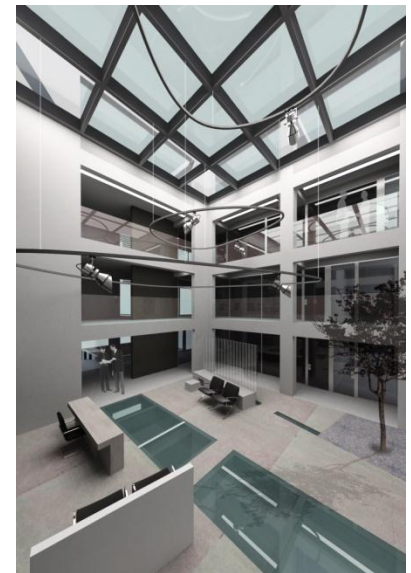
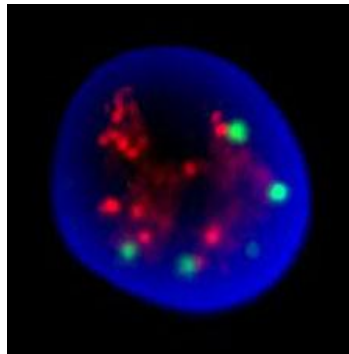
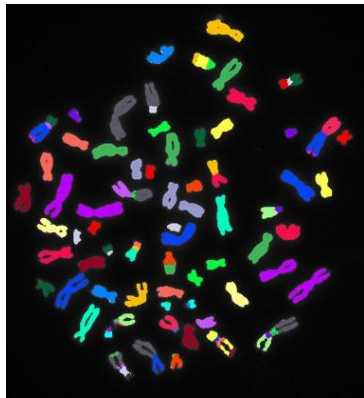
# BioGenomica S.A.

## Centre for Genetic Research and Analyses

High throughput genetic testing with applications mainly in molecular diagnostics and clinical genetics

### WHO-ROLE

End User Evaluation of Optical-Biosensor Devices for easy-to-use applications in single-nucleotide-polymorphism detection – Reference Lab for Custom-designed Clinical Trials



### APPLICATIONS:

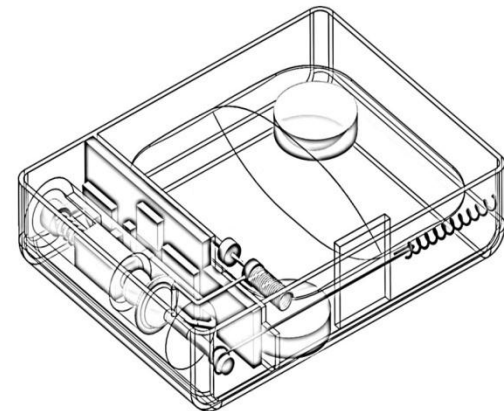
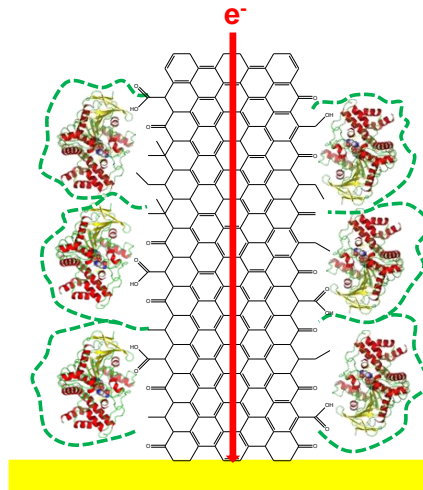
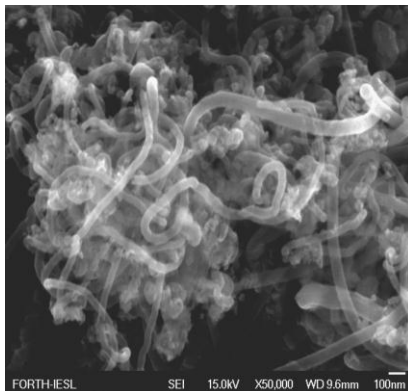
- Mutation Detection for Predisposition to Hereditary Diseases in Oncology, Cardiology and Neurology
- Pharmacogenomics

# Micrel Medical Devices S.A.

## Miniature Pancreas

### WHO-ROLE

Based on research of prof. Chaniotakis team at Univ. of Crete we enter dynamically into diabetes care. A self calibrating sensor is about to be animal tested this year, with so good expected accuracy that a miniature square inch pancreas (measurement + infusion + closed loop) is our target



### APPLICATIONS:

- Dual nanotechnology microfiber immobilization and Gox cover glucose sensor (Patent US2005/0011827)
- Self calibrating biosensor (Patent US1010/00228110 )
- Insulin pump (Patent US2011/0009814)

# Overview of MicroNanoBioSystems in Greece

## RESEARCH INSTITUTIONS

NCSR 'Demokritos'

National Hellenic Research Foundation

FORTH, Institute of Molecular Biology and Biotechnology

Biomedical Research Foundation, Academy of Athens

## ACADEMIC INSTITUTIONS

National Technical University Athens

Agricultural University of Athens, Department of Agricultural Biotechnology

University of Athens, Department of Chemistry, Analytical Chemistry Lab

University of Patras, Department of Chemistry

University of Ioannina, Laboratory of Chemical Sensors & Biosensors

## COMPANIES

micro<sup>2</sup>gen Ltd.

ThetaMetrisis S.A.

BioGenomica S.A.

Micrel Medical Devices S.A.



THANK YOU FOR YOUR ATTENTION