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NANOTIC

A 2005-2010 Program of Excellence of the
Wallon Region Government, Belgium

Université catholique de Louvain
(Engineering - Science - Medicine)

**« *Towards the Nano-Bio-ICT
Convergence...* »**



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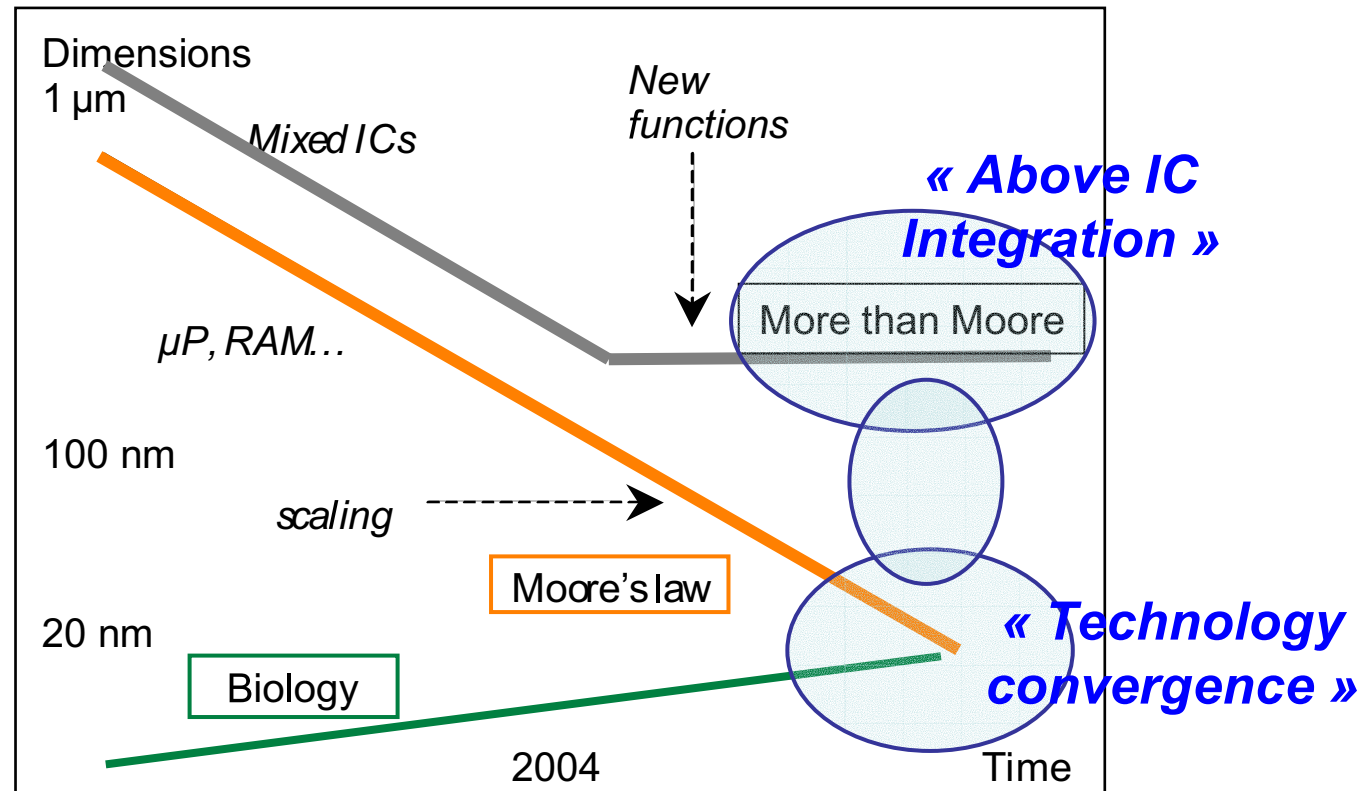
Nanotic : broad generic context

- Diagnose the malfunction of complex systems
(*human body, ecosystem, industrial process*)
 - Lies on the detection of specific informations :
 - Molecules (DNA, proteins, ..)
 - Gas or particles (pollutants, ...)
 - Physical data (T° , pressure, flow, ...)
 - Spatially distributed
 - Real-time observations
- Broad range of applications
 - Biomedical : new drugs, health care, ...
 - Environment : air quality monitoring, ...
 - Logistics and smart monitoring
 - Automotive
 - Aerospace...



Nanotic : the vision

Evolution of integrated technologies



« Micro/Nano-interface »

System Miniaturization is a major trend:
System-on-board → System-in-a-package → Microsystem!



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- In the long run, “ **swarms** ” of “dust” components or “ **motes** ” will become available,
embedding :
 - micro-nano-sensors
 - electronics
 - communication functions
 - data processing
- Need for a multi-disciplinary approach aiming at the progressive convergence of **Nanotechnologies, Information Communication Technologies and Biomedical Sciences**



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Nanotic : ressources & expertises

- **Creation and Functionalization of nano-objects**
 - Characterization and fabrication of nano-functionalized surfaces :
B. Nysten, A. Jonas, P. Bertrand, A. Delcorte [Materials Engineering]
 - Realization of nano-blocks for the functional sensing parts :
S. Demoustier, L. Piraux [Materials Engineering]
 - Synthesis and nanocharacterization of bio-receptors :
Y. Dufrène, P. Soumillon [Biology]
- **Fabrication of integrated components (silicon micro-nano-technologies)**
J.- P. Raskin, D. Flandre, S. Melinte, J. Proost, T. Pardoen [MEMS / Microelectronics / Materials Engineering]
- **Data processing and communication**
 - Transmission techniques : *L. Vandendorpe [Digital Communications]*
 - Information security : *J.-J. Quisquater [Cryptography]*
 - Massive data processing : *B. Macq [Information Technology]*
 - Design of very-low-power mixed electronics systems :
J.-D. Legat, D. Flandre [Micro/Nano-electronics]
- **Study of *ex vivo* or *in vitro* properties of such micro-components for cell anomaly identification** : *J.-L. Gala [Medecine]*



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Nanotic: A cluster of 5 projects

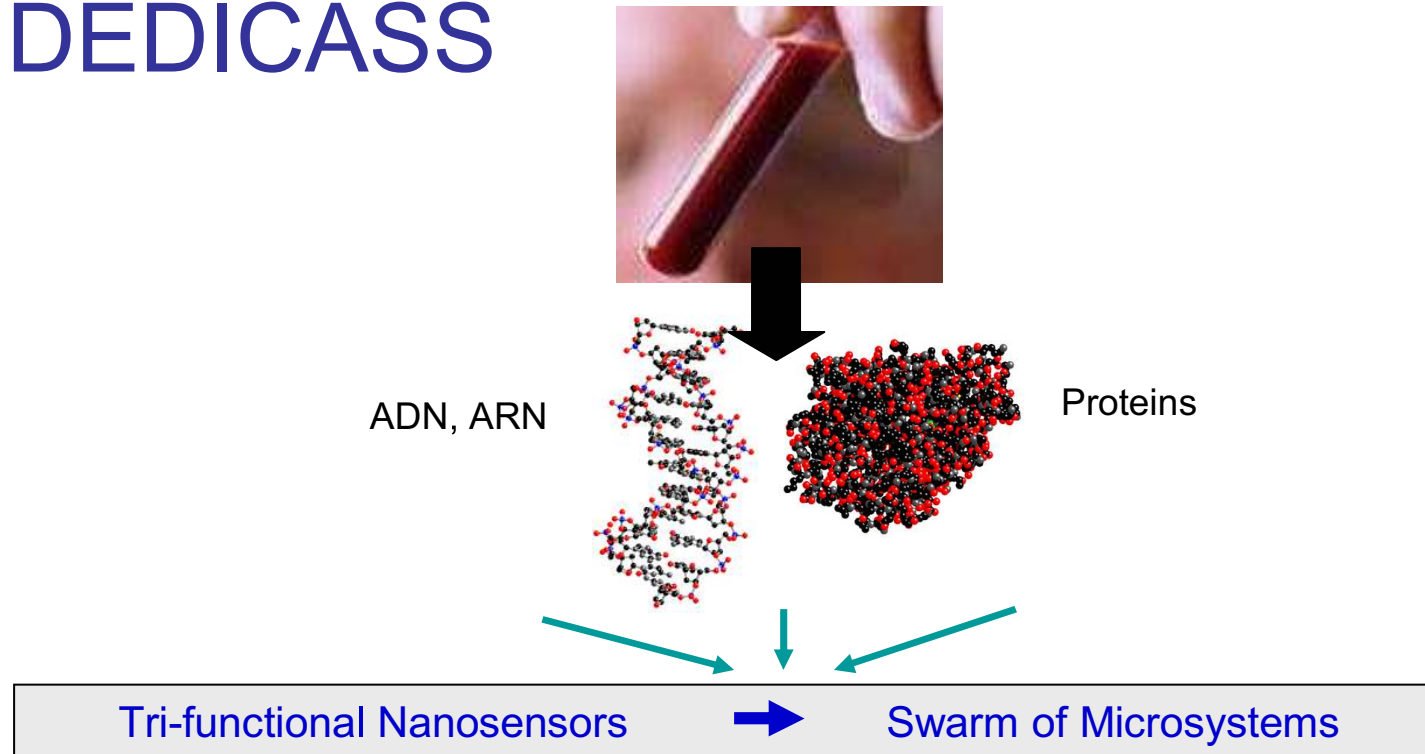
- **FEELING** : Molecular recognition and first signal generation
- **CITE** : Integrated electronics transducing components
- **TSARINE** : Stochastic signal processing for searching nano-data in swarms
- **COSMOS** : Secured communication wireless objects
- **DEDICCAS** : Deciphering of the various assembled cell compartments



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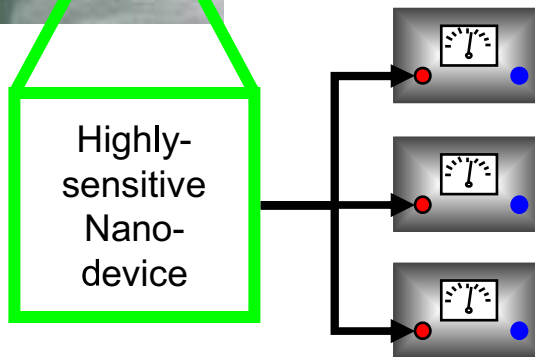
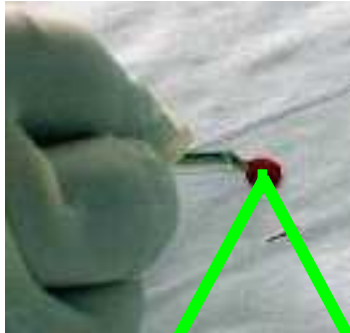
DEDICASS



- Combined, simultaneous and direct ADN, ARN and protein analysis of living cell nature, physiology and pathologies vs. Present indirect and separated detections (fluorescence, colorimetry, beads...)

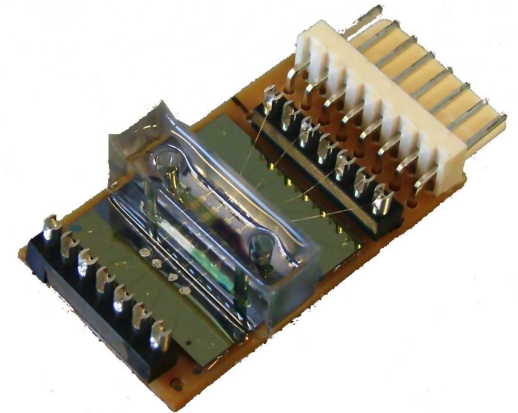
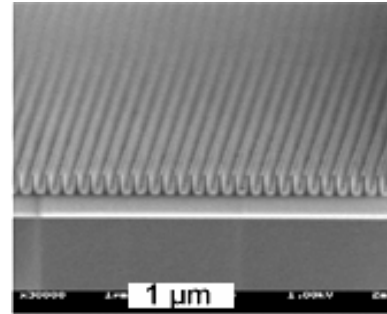


FEELING

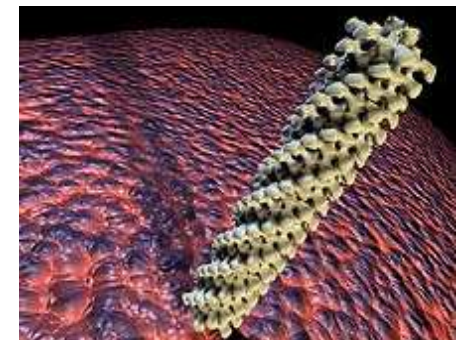
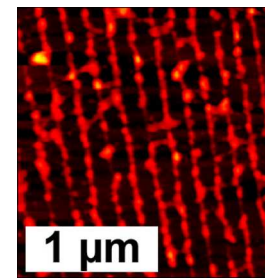
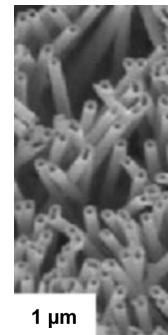


- *Fabrication*
- *Functionalization*
- *Characterization*

- Nanoelectrodes, conductive polymers



- Nanotubes, nanowires



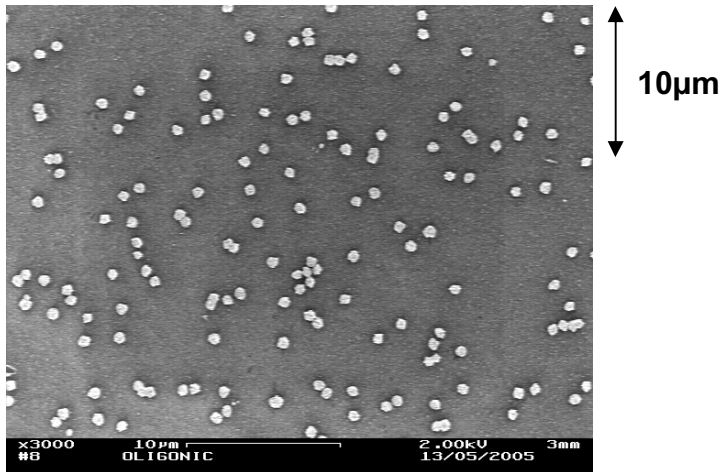


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CITE

Challenge : Detection of very low concentrations of molecules → very few, scattered, « events » hidden in « noise » or parasitics signals



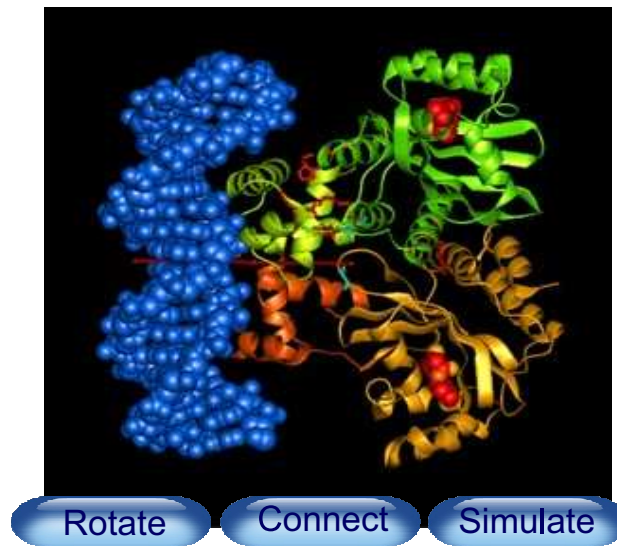
“SEM image” of the hybridization of
 $\approx 10^{-15}$ moles of DNA
(enhanced by metal labels)

⇒ **Arrays of small « pixel detectors »:**

- On-chip electronics circuits for individual addressing and very sensitive read-out of each pixel
- Co-integration of nano-sensors (electrodes, nanowires, M(N)EMS)
- Biocompatible thin coating layers (metal oxide < 100 nm) to protect and interface molecules, sensors and electronics.

TSARINE

- 3D Manipulation of molecule structures



- Data fusion of multi-modal sensors
(e.g. smart wear)



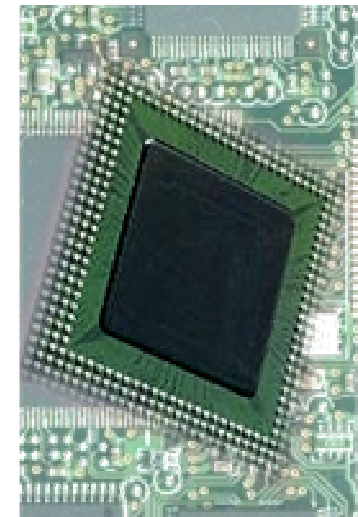
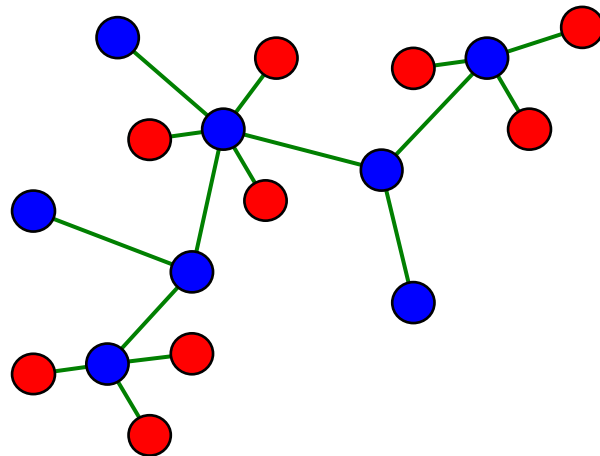


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COSMOS

- UWB transmission and node positioning



- Secure the communication between sensors dispersed in an rather unknown and potentially hostile media and one or several base stations



Nanotic: Methodology for innovation

DEDICASS

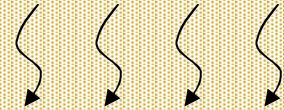
*Domain:
What to detect ?
How ?*

*Micro/Nano-
fabrication*

*New electronic circuits:
How to Improve ?
Fabricate ?*

CITE

Environment



**New materials,
structures, functions**



IC (Si CMOS)



HW/SW System

FEELING

*Sensibility/
specificity*

Interfaces

*Signal
Processing,
Communication*

COSMOS TSARINE