LAUREA MAGISTRALE IN INGEGNERIA DELLE NANOTECNOLOGIE

Percorsi di completamento:

- ***Elettronica***
- ***Biotecnologie***

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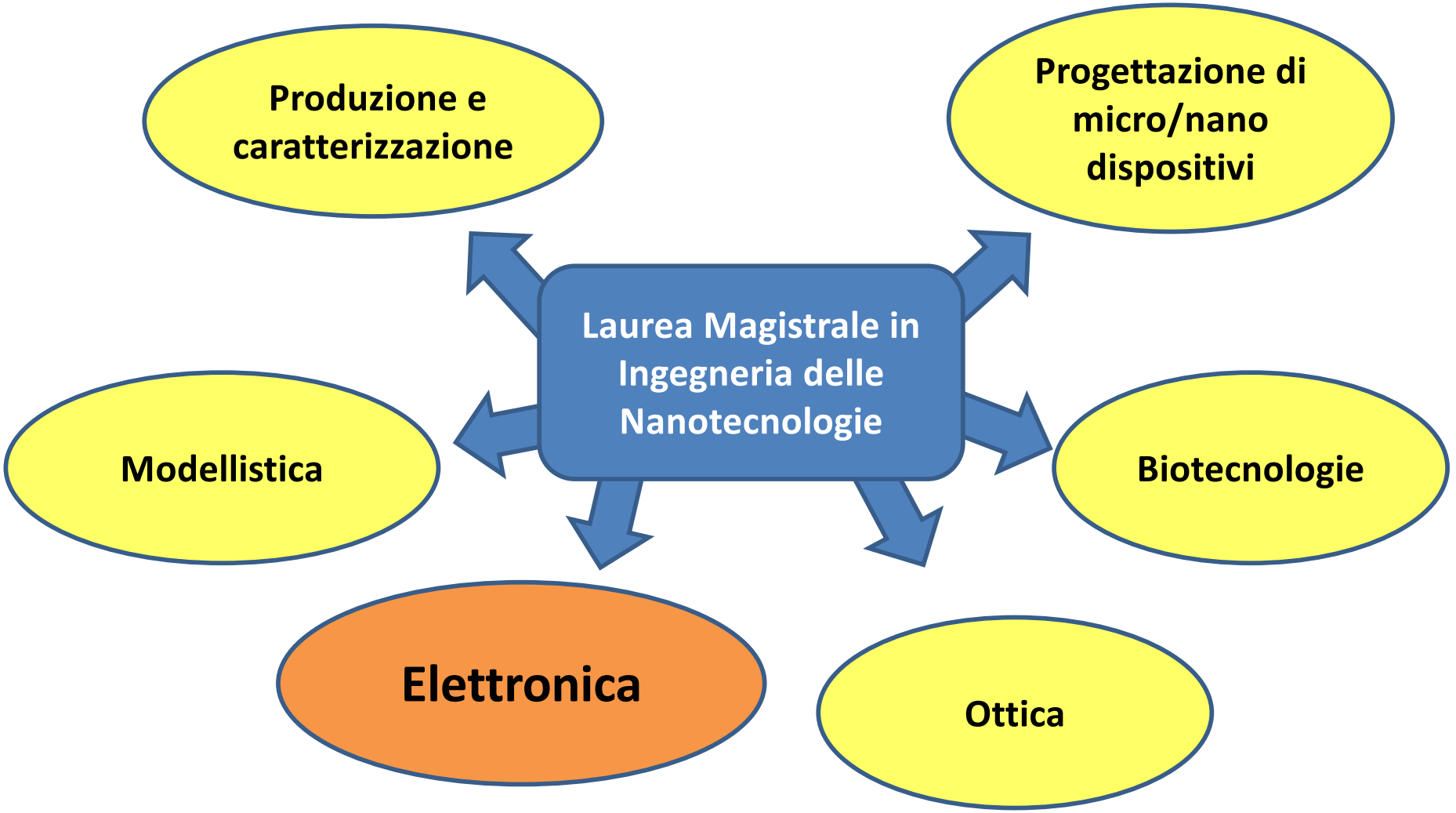
I 6 Percorsi di Completamento



Percorso Elettronica (P4)

obbligatorio

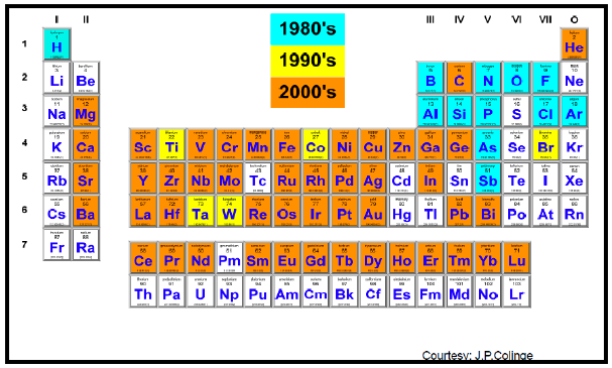
-Componenti nanoelettronici e microelettromeccanici integrati (UDI: 12 CFU)

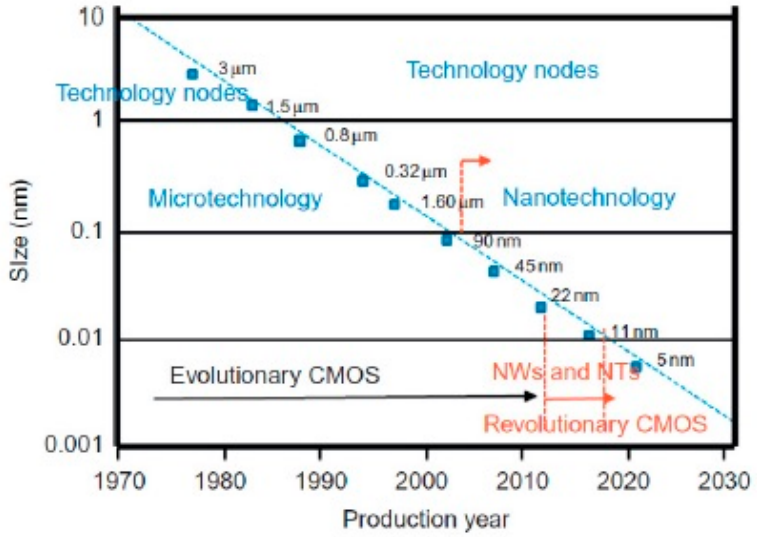
2 corsi di carattere applicativo / sperimentale + **2 corsi d'indirizzo**

- Elettronica:
  - **Nanoelectronics Laboratory (UDI)**
  - **Dispositivi Nanoelettronici di Sensing innovativi**
  - **Tecnologie e Processi per l'elettronica**
  - **Optoelectronics**
  - **Microsistemi fotonici**
  - **Electromagnetic Fields and Nanosystems for Biomedical Applications**

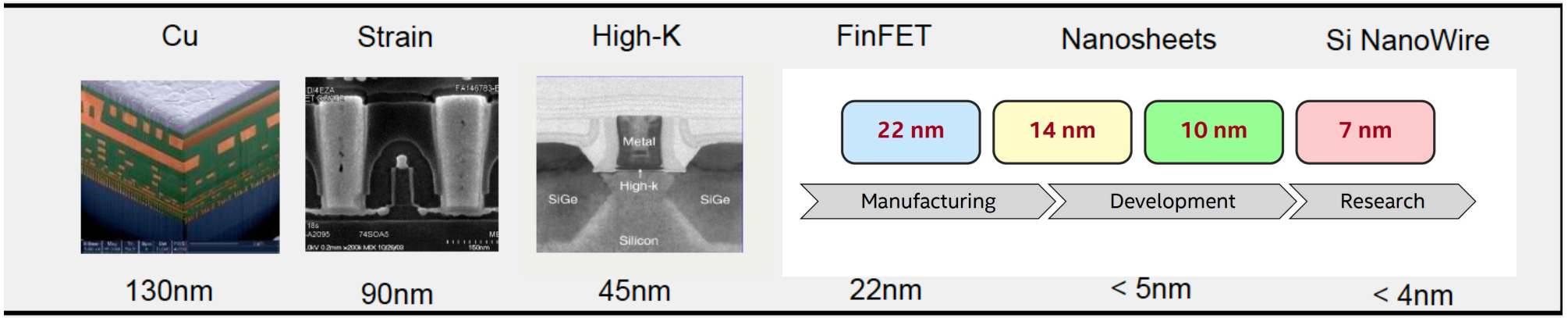
Evoluzione tecnologia CMOS

Innovation in materials and architecture pushed by reaching the limit of existing solutions



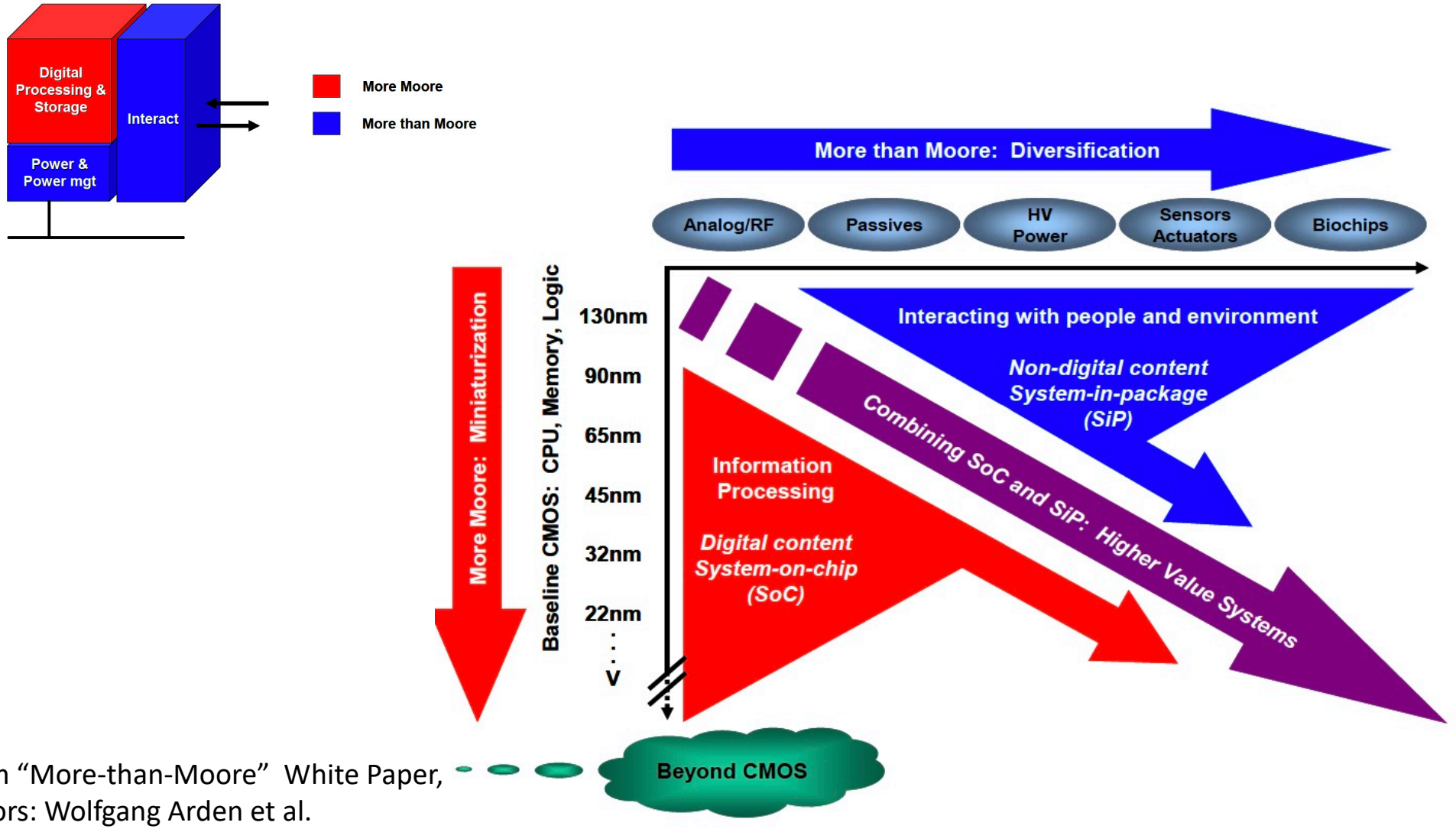


Scaling in CMOS



from Synopsys

Miniaturizzazione e diversificazione



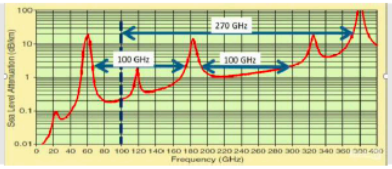
from "More-than-Moore" White Paper, Editors: Wolfgang Arden et al.

Applicazioni sempre più ‘demanding’

Applications

Technology

mmWave Comm.



Where to find the spectrum for 1 Tb/s

Automotive Radar

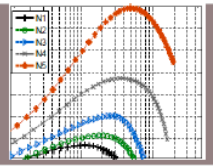
24GHz, 76-77GHz today
79GHz, 122 GHz in the future
In cabin monitoring, Road surface det.
Automated driving

Security Medical Scanning

A lot phenomena in solids, liquids and gases occur in the THz domain

- Industrial analysis
- Astrophysics, Atmospheric, Chemistry
- Biomedical, detect bacteries, …

SiGe RF-CMOS III/V



SiGe: f_{max} = 400 GHz today, 600 GHz soon
RF-CMOS: FDSOI, FinFET, Nanowire - future
III/V: for THz and high output power

Frequency

- AI, Deep Machine Learning
  - Computer driven sophisticated routines with high need for data crunching
- Automotive
  - A plethora of sensors making sensitive real-time driving decisions based on collected data
  - Complex communications system integrating a heterogeneous set of sensors, microprocessors, and communication devices
- IoT
  - IoT hyperconnectivity theme: hyperconnectivity value chain: sensing, communication, computing and storage, energy harvesting, security, services
- Virtual Reality / Augmented Reality
  - Virtual display of real and simulated environments ranging from gaming all the way through sophisticated military applications

Emerging Technologies

- In-memory Computing
- Cold CMOS
- Superconducting Electronics
- Spintronics
- PCMs
- ReRAMs / RRAMs
- Optical Communications
- Qubits

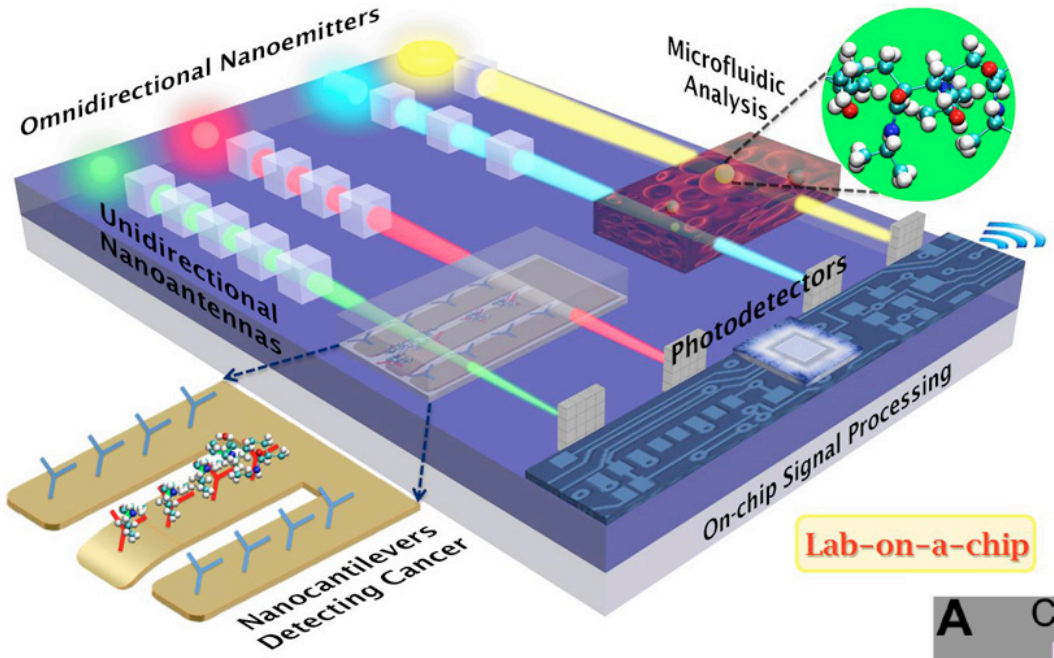
I 6 Percorsi di Completamento

Percorso Biotecnologie (P6)

2 corsi di carattere applicativo / sperimentale + 2 corsi d'indirizzo

- Biotecnologie:
  - **-Laboratories of Atomistic and Micro-Nano- Fluidics Simulations (UDI)**
  - **- Biophotonics Laboratory**
  - **- Macromolecular Structures**
  - **- Principles of Biochemical Engineering**
  - **- Electromagnetic Fields and Nanosystems for Biomedical Applications**
  - **-Sintesi e caratterizzazione di bio- nano-materiali (UDI)**

Applicazioni nell'ambito delle biotecnologie: lab-on-chip



NEMS Lab-on-chip:

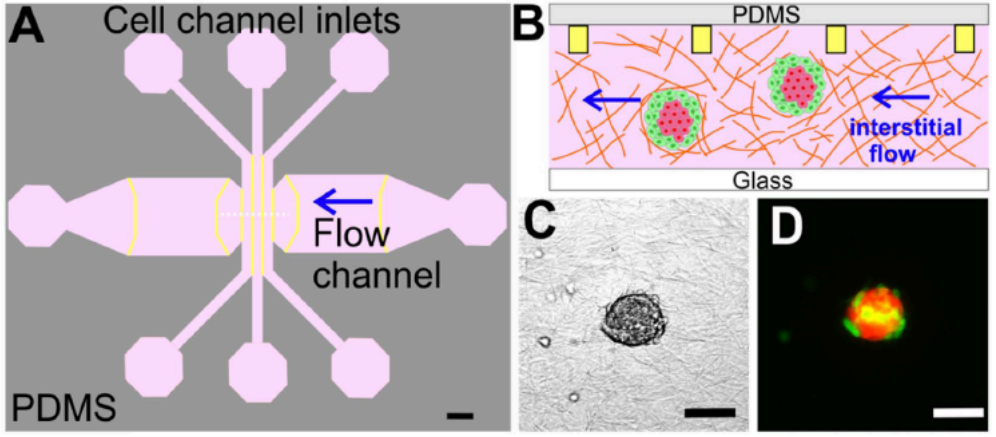
-**micro/nano fluidics**

-**optics**

-**electronics**

-**MEMS design**

Lab-on-a-chip is a class of device that integrates and automates multiple laboratory techniques into a system that fits on a chip up to a maximum of a few square centimetres in size.



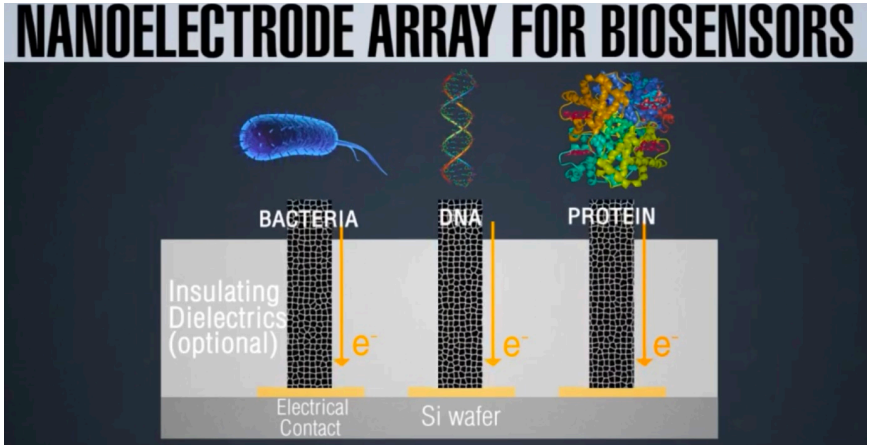
Huang et al. Sci Rep 2020

Applicazioni nell'ambito delle biotecnologie: biosensing

WHAT IS EXPECTED FROM A WELL-DESIGNED BIOSENSING SYSTEM?

- Small size, mass
- Low power consumption
- Minimal (chemical) resources and human processing
- Reasonably rapid analysis
- Negligible false alarms
- Multiplexing capability for detecting multiple targets
- Reliability and robustness

Example



NANOELECTRODE FOR SENSORS

NANOSCALE ELECTRODES CREATE A DRAMATIC IMPROVEMENT IN SIGNAL DETECTION OVER TRADITIONAL ELECTRODES

TRADITIONAL MACRO- OR MICRO- ELECTRODE

ELECTRODE

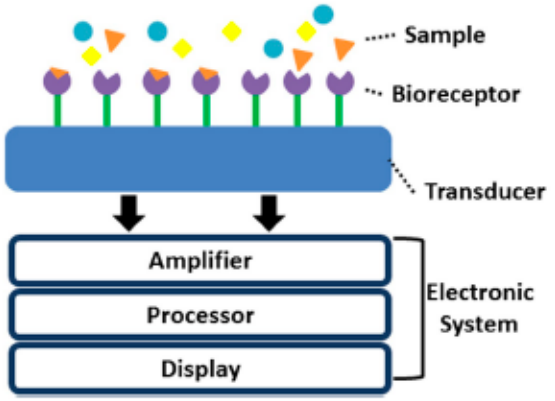
- SCALE DIFFERENCE BETWEEN MACRO-/MICRO- ELECTRODES AND MOLECULES IS TREMENDOUS
- BACKGROUND NOISE ON ELECTRODE SURFACE IS THEREFORE SIGNIFICANT
- SIGNIFICANT AMOUNT OF TARGET

NANOELECTRODE ARRAY

INSULATOR

NANO- ELECTRODE

- CNT TIPS ARE AT THE SCALE CLOSE TO MOLECULES
- DRAMATICALLY REDUCED BACKGROUND NOISE
- MULTIPLE ELECTRODES RESULT IN MAGNIFIED SIGNAL AND DESIRED



Contatti

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