Nanoparticle based biosensors for diagnostics

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Nanobioelectronics & Biosensors Group

ETSE (UAB), Bellaterra, 2010

Outline

Introduction

- Diagnostics & Biosensors
- Electrochemical Biosensors based on Nanoparticles

Detection tools

- Electrochemical detection of Nanoparticles

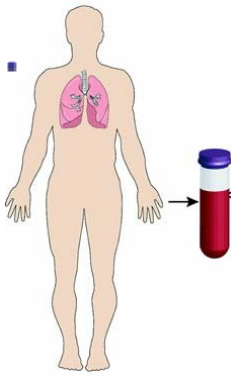
Application:

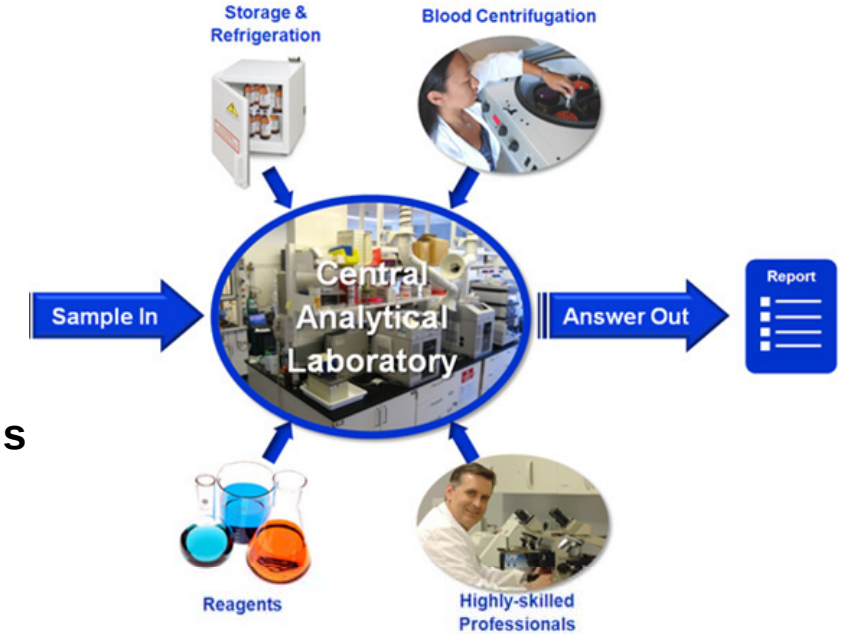
- DNA hybridization detection
- Protein detection
- Tumour Cells detection

Conclusions

Diagnostics & Biosensors

Traditional process…





- Time consuming
- Expensive equipments/materials
- Specialized professionals

Point-of-care technology…

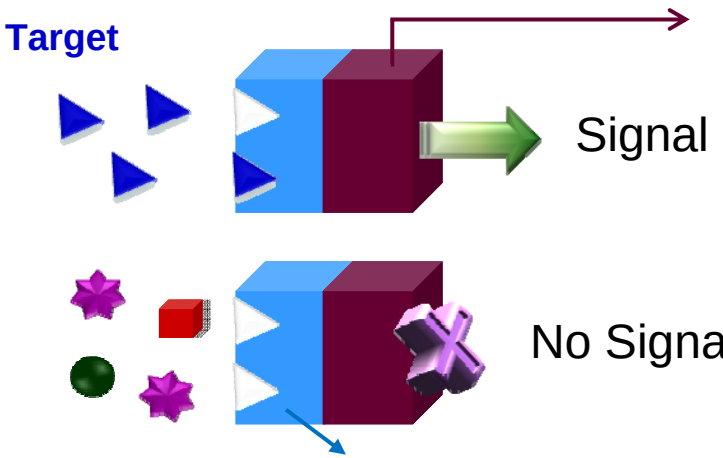
- Portable Diagnostic Instruments
- Self-Contained Diagnostic Kits
- Ready-to-use Reagents
- Small Laboratory Systems

http://www.fluigence.com/
http://www.medicaldisposablespr.com/

Electrochemical Biosensors based on Nanoparticles

- Introduction
- Detection tools
- Application:
  - DNA
  - Proteins
  - Cells
- Conclusions

Biosensor

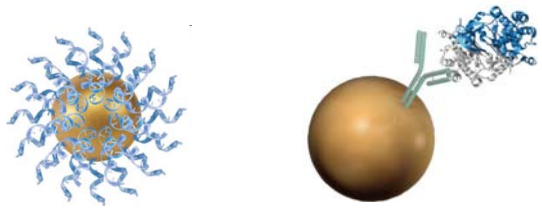


- Optical
- Thermical
- Gravimetric
- **Electrochemical**

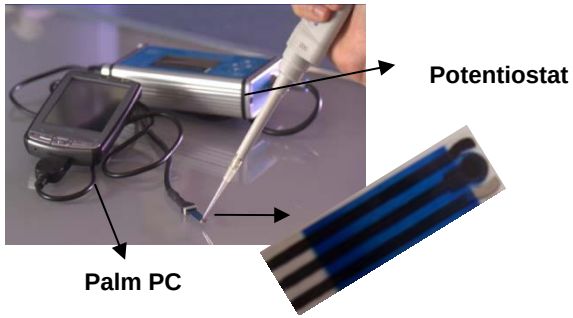
- Easy to use
- Low Cost
- Lower time
- Miniaturization

Nanoparticles

- Biocompatibility
- Rapid and simple chemical synthesis
- Excellent electroactivity
- Efficient coating by biomolecules



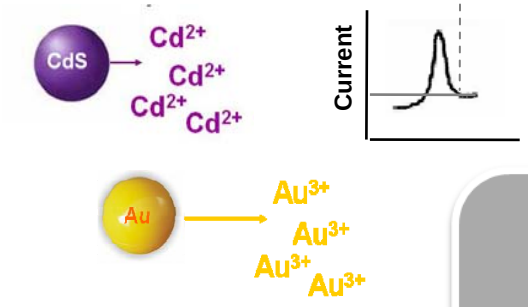
SPCE as electrotransducers



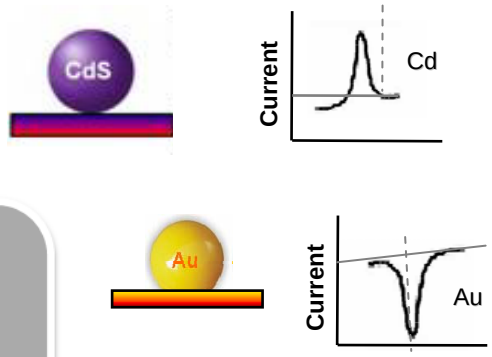
- Electrochemical advantages
- Low sample volumes (30μL)
- Single use
- Miniaturization/portability

Detection tools: our technologies

I. Electrochemical Stipping after dissolving

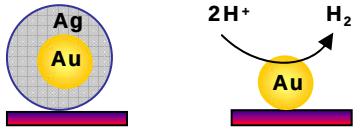


II. Direct DPV detection

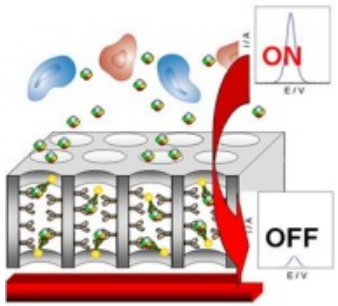


Based on nanoparticles

III. Electrocatalytic detections (Silver deposition, Hydrogen evolution)



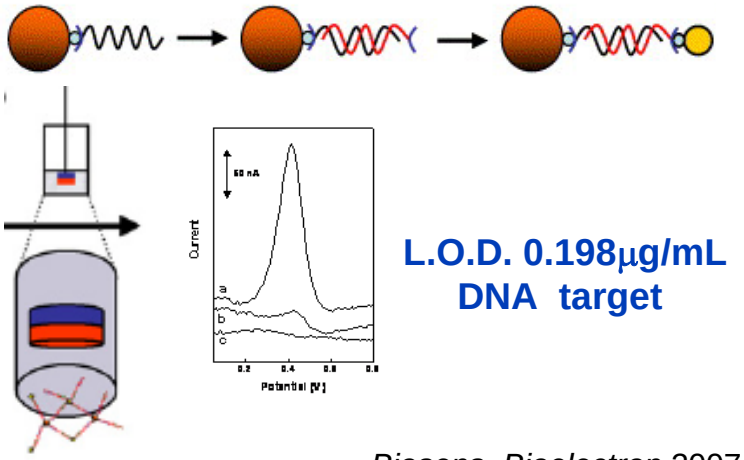
IV. Indirect detection through nanochannels blocking



DNA detection based on NPs

- Introduction
- Detection tools
- **Application:**
  - •DNA
  - Proteins
  - Cells
- Conclusions

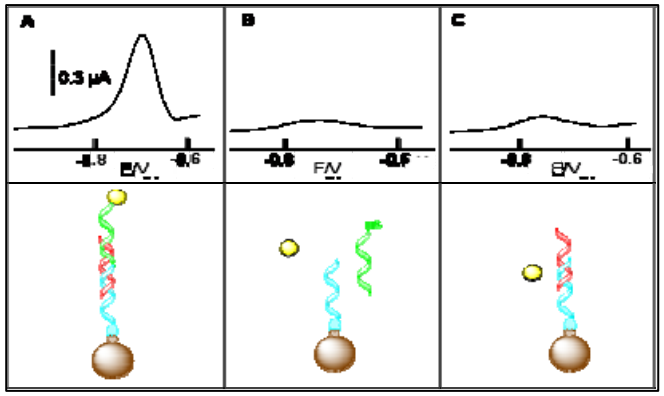
Breast Cancer related



L.O.D. 0.198μg/mL
DNA target

*Biosens. Bioelectron.*2007

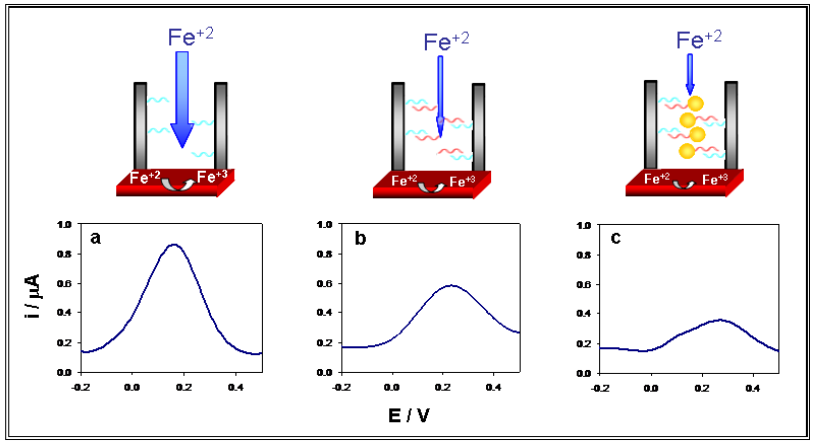
Cystic Fibrosis related

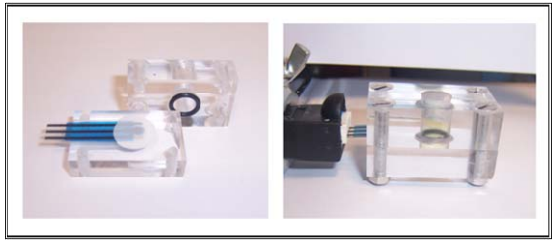


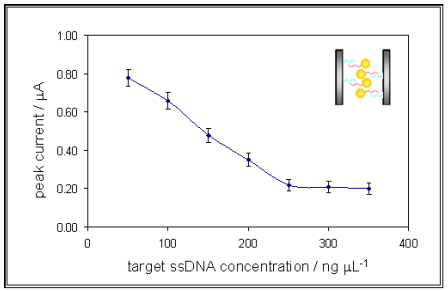
L.O.D. 1.82μg/mL
DNA target

Nanotechnology 2009

Detection through blocking of nanochannels







De la Escosura *et al. Chem. Com.* 2010

General platforms for protein detection

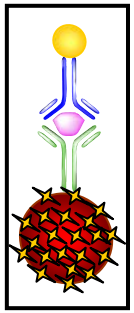
- Introduction
- Detection tools
- Application:
  - DNA
  - •Proteins
  - Cells
- Conclusions

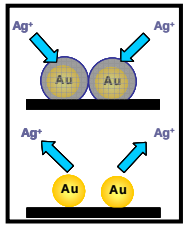
Silver electrocatalytic deposition

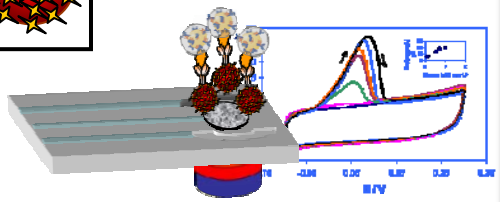
AuNP/αHIgG

HIgG

MB/α-HIgG



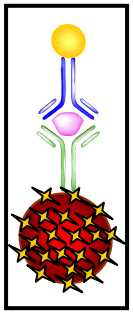


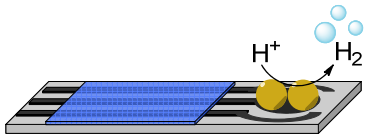


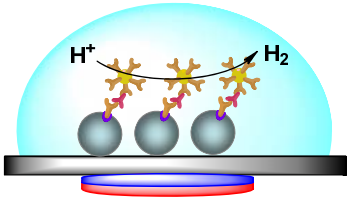
L.O.D.
23 fg/mL HIgG

De la Escosura *et al.*
Biosens. Bioelectron. 2009

Hydrogen evolution electrocatalysis







L.O.D.
1.45 ng/mL HIgG

Maltez da Costa *et al.*
Electrochem. Com. 2010

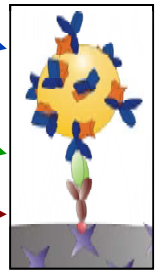
Human IgG

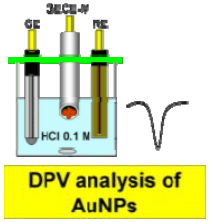
Double detection

AuNP/
αHIgG-HRP

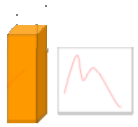
HIgG

MB/α-HIgG





DPV analysis of AuNPs

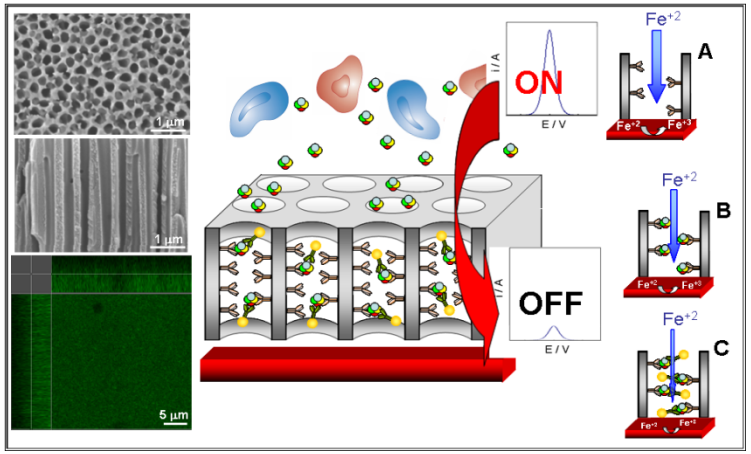


Optical analysis based on HRP

L.O.D.
65 pg/mL HIgG

Ambrosi *et al. Anal. Chem.* 2007

Detection by nanochannels blocking



De la Escosura *et al. Electrochem. Com.* 2010

Introduction

Detection tools

Application:

DNA

• Proteins

Cells

Conclusions

Detection of HepB antibodies in Human serum

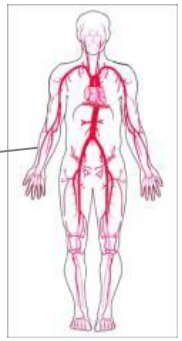
Collaboration with Dr. A. González (UV)

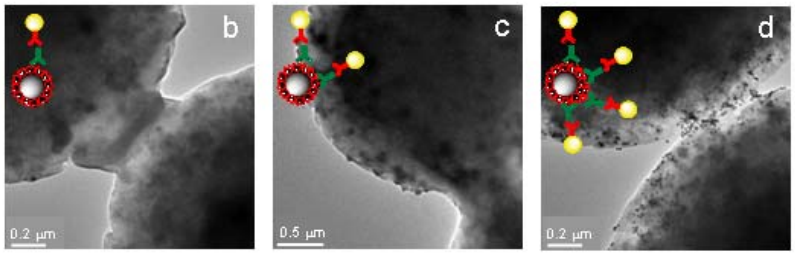
anti-Hum IgG/AuNP →

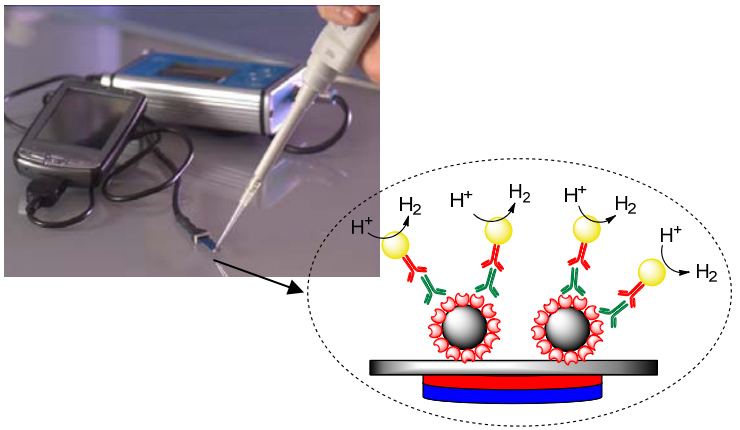
Human serum

HBsAg →

Superparamagnetic Micro beads







Using the catalytic effect of AuNPs onto HER:

L.O.D: 3 mUI HBV Ab / mL

De la Escosura *et al, Biosen. Bioelectron.* 2010

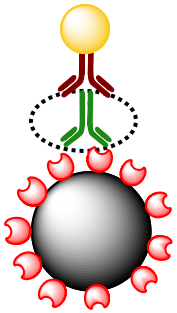
Detection of breast cancer marker (Ca15-3)

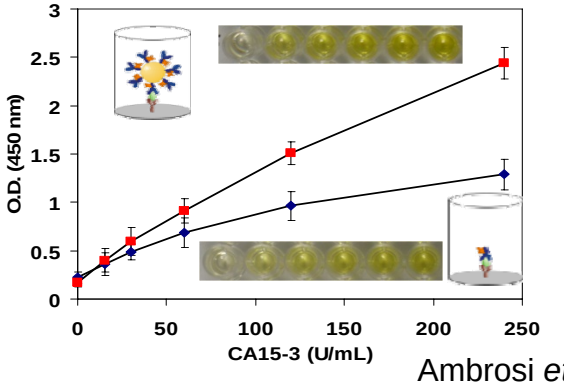
Project Valtec number 08-1-0007

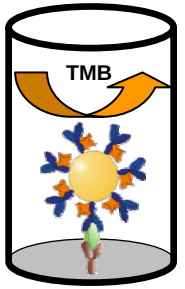
Specific Antibody /AuNP →

Breast cancer marker

Specific Protein/ Superparamagnetic Micro beads →





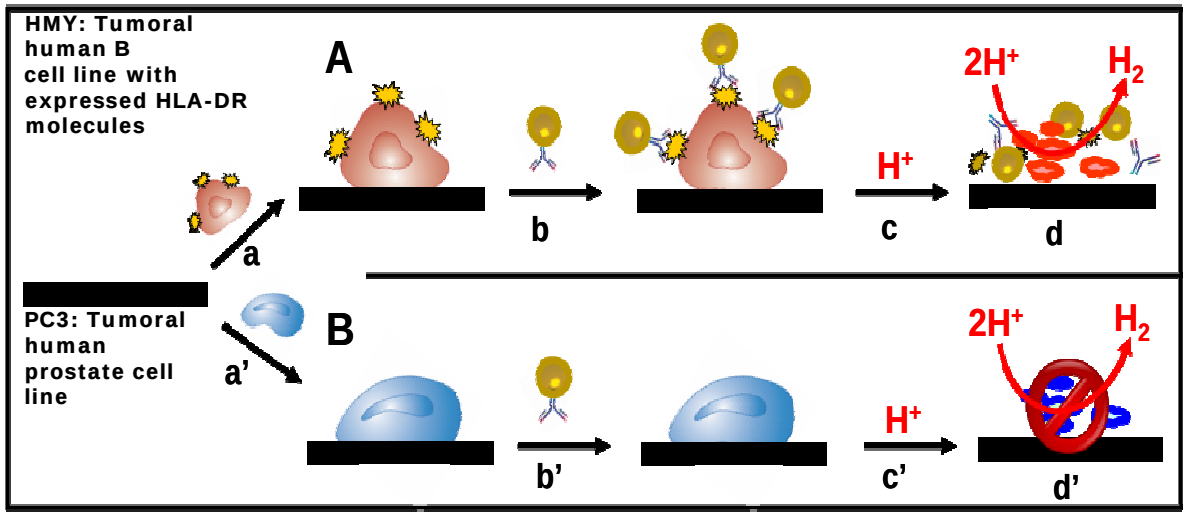


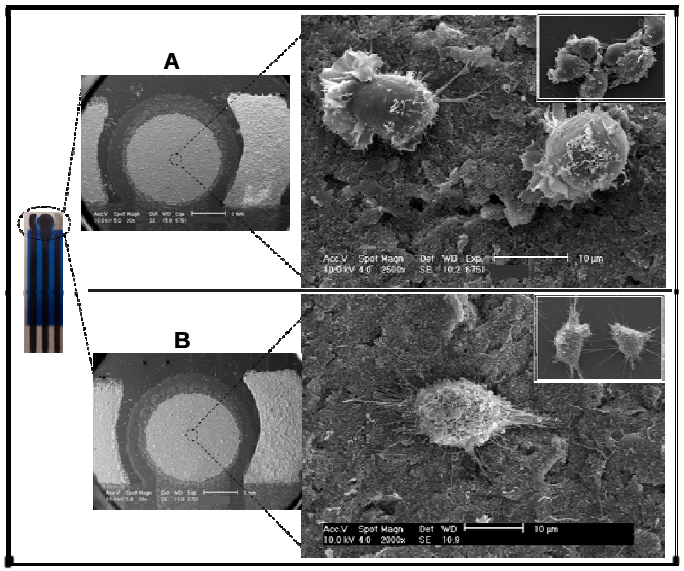
Ambrosi *et al, Anal. Chem.* 2010

Tumor Cell detection based on AuNPs

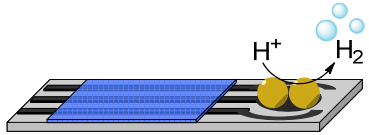
Collaboration with Dr. A. González (UV)

Patent ICN/UVI: P1217E500





Using the catalytic effect of AuNPs onto HER



LOD:
4000 cells/ 700 μL sample

De la Escosura *et al. Anal. Chem.* 2009

Conclusions

- Several platforms for DNA, protein and cell detection are already available for laboratorial use.

- Further technological developments are necessary for point-of-care applications.

- Collaborations with clinical labs and pharmaceutical companies are necessary for special applications & developments following the clinical / market needs.

Acknowledments

Previous collaborators

F. Airò (UM, Italy)
G. Alarcon. (UNAM, Mexico)
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A. Gonzalez (UV, Spain)
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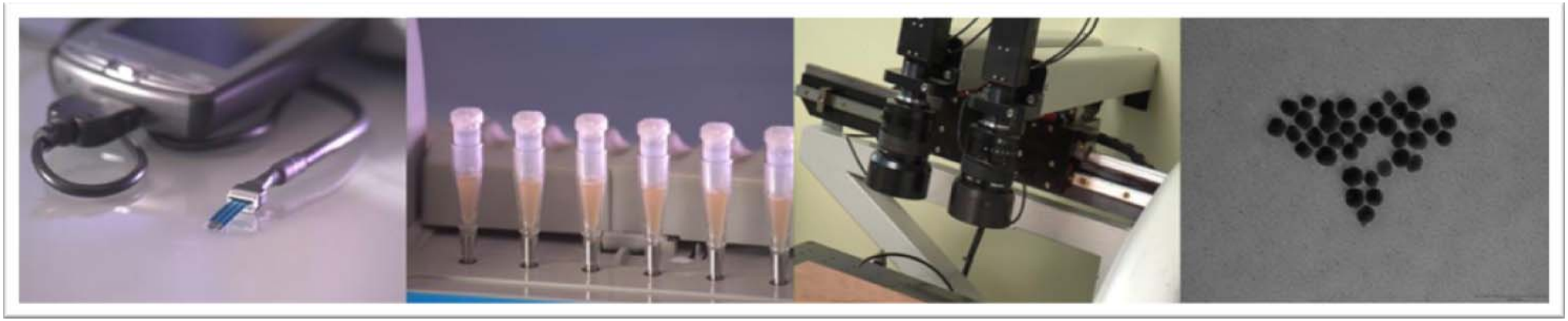

THANK YOU FOR YOUR ATTENTION !

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