

NANOBIOSENSORS FOR DIAGNOSTICS

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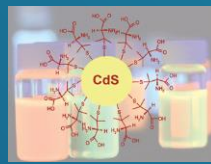
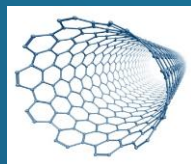
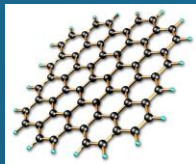
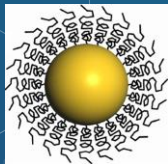
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NANOBIOELECTRONICS AND BIOSENSORS

The Group

Focuses on the **discovery** and **technological development** of cutting edge nanotechnology and nanomaterials to create **simple and cost effective nanobiosensing platforms**. We do this by controlling their architectures on both the **nano** and **macro** scales with the objective to link these two worlds.



Application areas:

- ✓ Diagnostics
- ✓ Environmental Monitoring
- ✓ Food quality
- ✓ Safety / security
- ✓ Other industrial applications

Technology transfer:

paperdrOpdx

Graphenicalab

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MEDICAL/ENVIRONMENTAL DIAGNOSTICS

Traditional laboratory techniques

- ✓ Sensitivity
- ✓ Information
- ✓ Suitable for basic research

- ✗ High costs
- ✗ Time consuming
- ✗ Sophisticated equipment
- ✗ Trained users
- ✗ Facilities
- ✗ Low throughput



<http://www.rdkengineers.com/Boston-Heart-Diagnostics.cfm>



http://www.lekhisoftmedicalsoftware.com/products/diagnostic_management

Point of care diagnostics (POC)

- In situ/immediate testing.
- Close control and monitoring



<http://cpoct.com/blog/>

Molecular
diagnostics

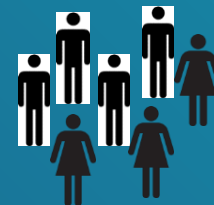


→ Biosensors



<http://continuuminnovation.com>

→ People



New advances



Biosensors



Diagnostics

POINT OF CARE (POC) DEVICES FOR HEALTH AND ENVIRONMENT CAN/SHOULD BE EVERYWHERE



Medical
devices



Smart
Fridge



Wearables



Smart
washing
machine



Smart houses



Smart Phone



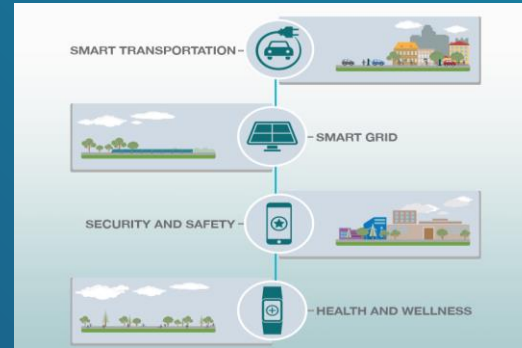
Smart TV



Food/plant
control



Environment
control



Smart cities

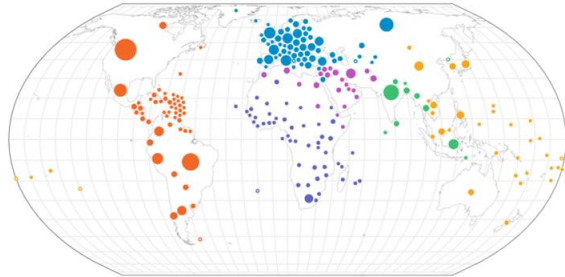
COVID-19: A tremendous real world example

We have been living through a global crisis

Showing the necessity of efficient diagnostics
for the protection of us all

Number of COVID-19 deaths reported to
WHO (cumulative total)

World



WHO Regions

■ Africa ■ Americas ■ Eastern Mediterranean ■ Europe
■ South-East Asia ■ Western Pacific

7,073,466

+641

increase on previous 7 days

Reported COVID-19 deaths

World, 7 days to 27 October 2024

Number of COVID-19 deaths
reported to WHO
(cumulative total)

World

Country	Deaths ▼
World	7.1m
United States of America	1.2m

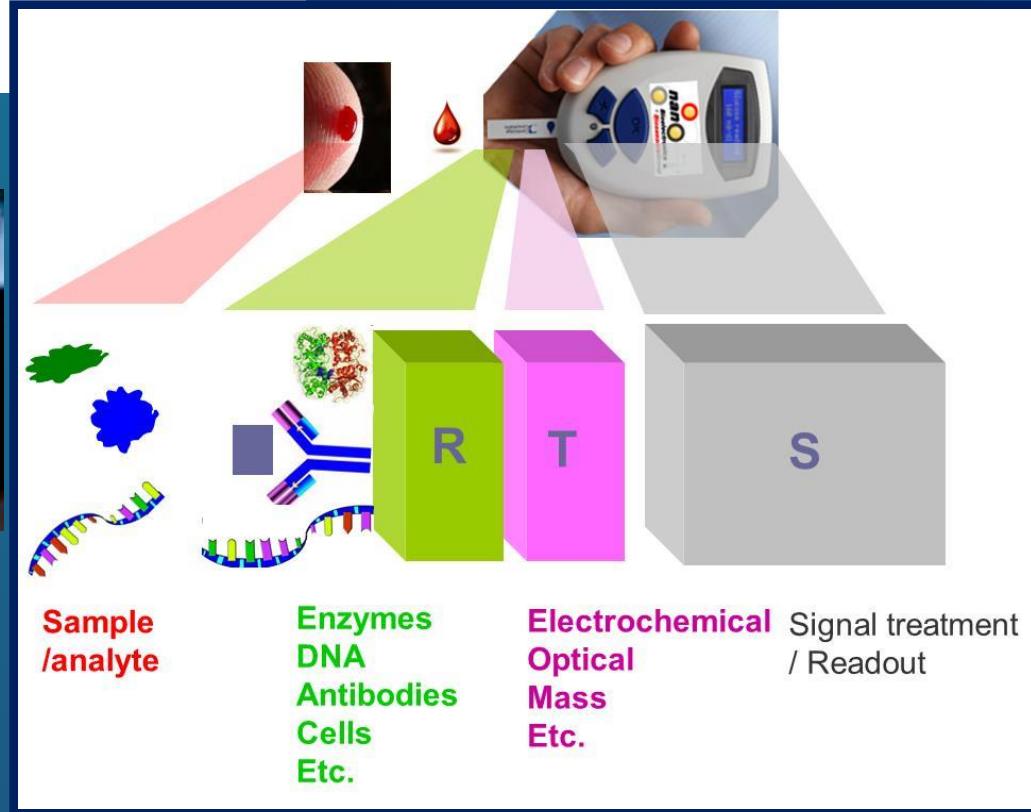
DIAGNOSTICS
TOOLS ARE CRUCIAL





www.fiercebiotech.com

FROM BIOSENSORS TO NANOMATERIAL-BASED ONES NANOBIOSENSORS



VARIETY OF CONFIGURATIONS

- Wearable sensors
- Smart/packaging /food control
- Implanted devices
- In-vivo formats

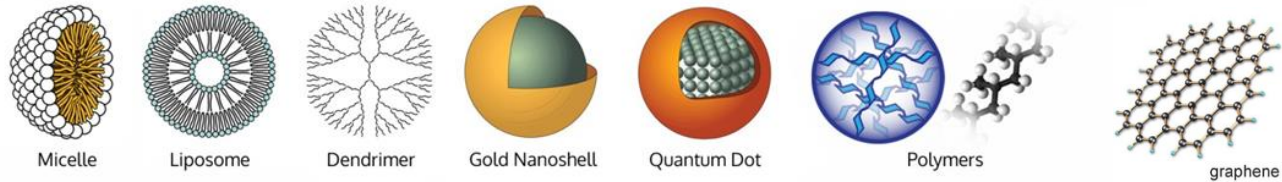
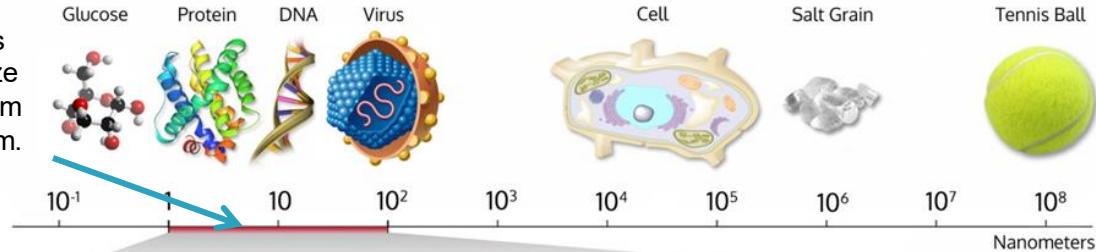


EXACTIVE EQ Diabetes

Testing Kit

- New source of possibilities to improve biosensors.
- Most of expectations comes from the fact that matter behaves differently at the nanoscale
- Plenty of new possibilities emerge from nanomaterials.

Materials
whose size
ranges from
1 to 100nm.



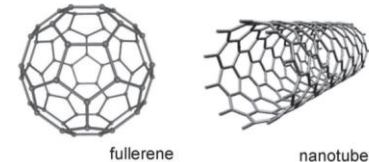
<http://wichlab.com/research/>

Nanomaterials advantages:

- Large surface-to-volume ratio
- Shape
- Physicochemical properties regarding composition
- Binding characteristics

Examples of nanomaterials:

- **Nanoparticles**
- Nanowires, nanotubes
- Graphene
- **Nanochannels**
- Nanostructured surfaces.



Fullerenes, Graphene and Carbon nanotubes

<http://www.naturphilosophie.co.uk/graphite-graphene-kitchen-blender/>

DEMOCRATIZE THE DIAGNOSTICS



- Innovative nanomaterials and nanotechnologies
- In-situ and easy production
- Low-cost scalability
- Portability
- Sensitive, reproducible
- Equipment-free



OUR RESEARCH

Nanomaterials

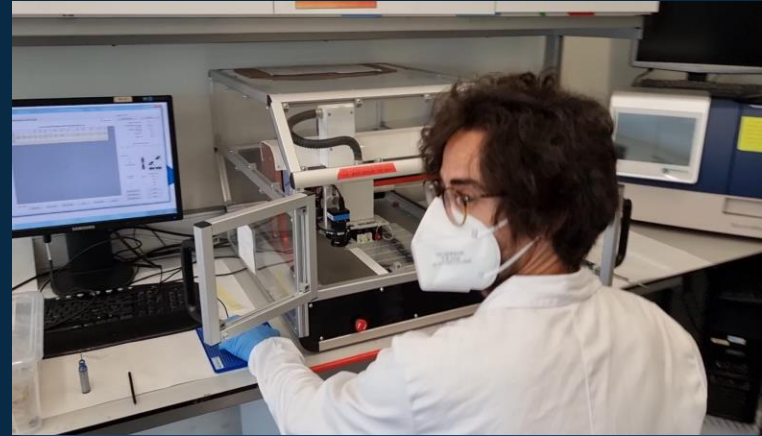
Graphene and 2D materials,
Metal nanoparticles, quantum dots

Paper-based

Lateral flow assay, hybrid electrochemical/LFA, optical readout

Printing technologies

Inkjet printing, screen printing, graphene transfer electrodes, FET-based biosensors, electrochemical readout



Fully integrated PoC devices

Smartphone based, wearables, wireless readout

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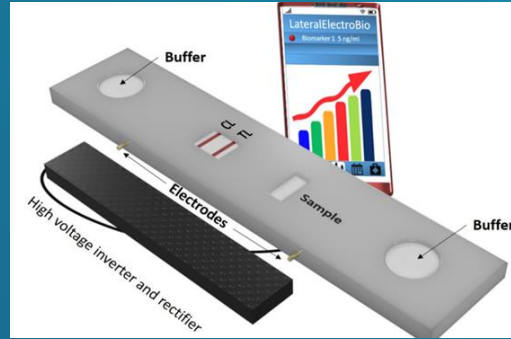
Electrical devices

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Conclusions

2 OPTICAL SENSORS

- ◆ Colorimetric
- ◆ Fluorescent
- ◆ Electrochromic
- ◆ Bioluminescent



Low cost

Easy to use

Fast

Naked eye detection

Mostly Qualitative

Limit of detection

Multiplexing

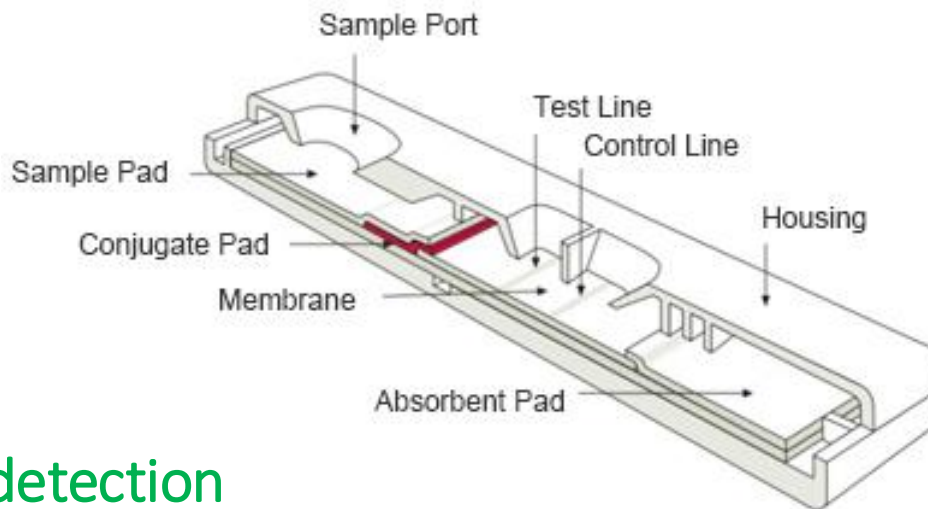


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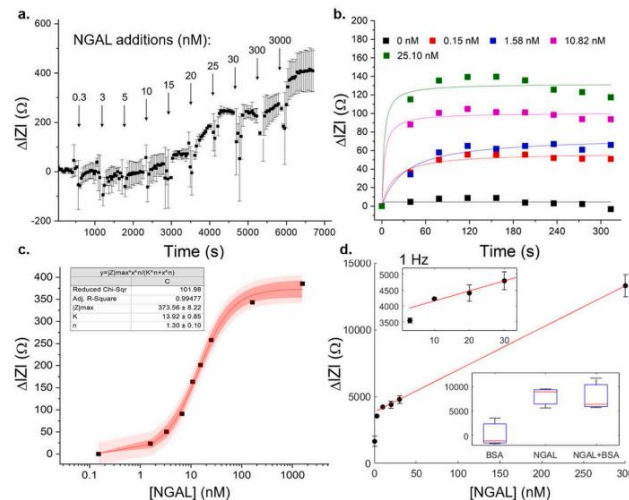
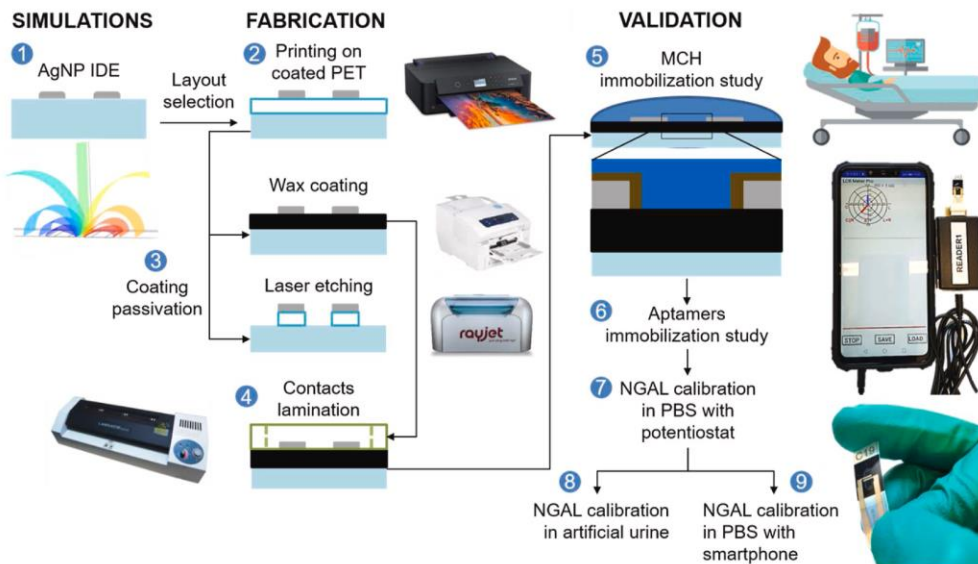
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Electrical devices

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Conclusions

A plug, print & play inkjet printing and impedance-based biosensing technology operating through a smartphone for clinical diagnostics

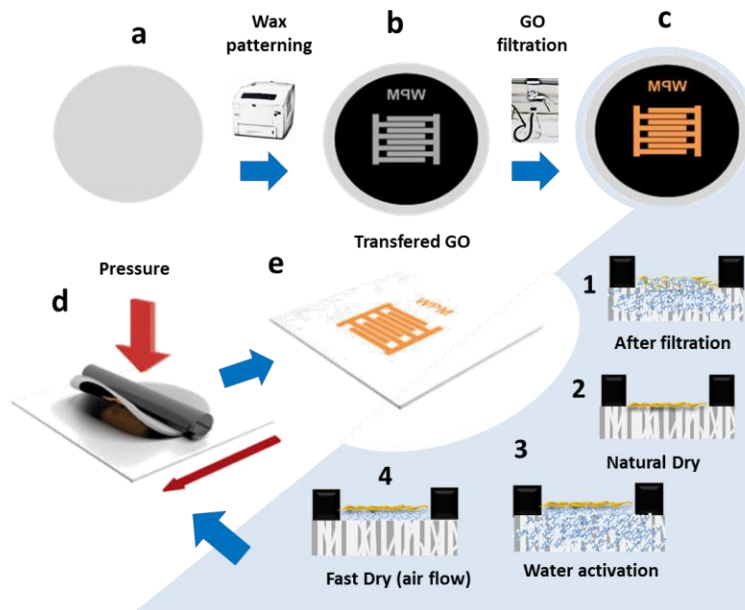


We fabricated a nanobiosensor based on aptamers NGAL.

The concept in a nutshell: 1. Draw your biosensor on your PC 2. Load nanomaterials in your consumer inkjet printer 3. Print your nanobiosensor 4. Functionalize it with aptamers 5. Connect it to your smartphone 6. Get your result!

NGAL (Neutrophil Gelatinase-Associated Lipocalin)
NGAL in urine is a biomarker of acute kidney infection (AKI) and of liver cirrhosis

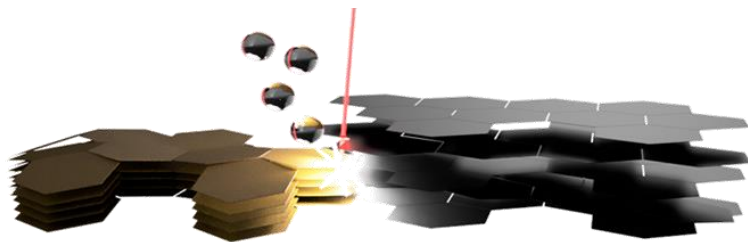
Water Activated Graphene Oxide Transfer Using Wax Printed Membranes for Fast Patterning of Electrical Devices



Video of printing

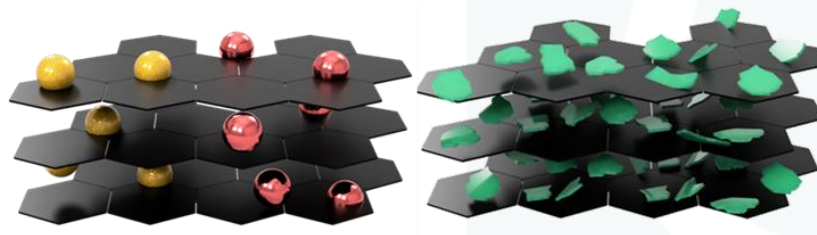


Laser-reduced graphene oxide: Our approach



GO (non conductive)

rGO (conductive)



- Au@rGO
- Ag@rGO
- Pt@rGO

- Transition metal dichalcogenides@rGO
(MoS₂, WS₂, MoSe₂, and WSe₂)



- Transferrable onto any substrate
- Solvent free
- Scalable fabrication



- Energy Storage Devices
- Sensors and Biosensors
- Catalysis and Electrocatalysis
- Flexible and Wearable Electronics
- Biomedical Applications
- Environmental Applications

Conclusions

Nanomaterials with interesting optical and electrical properties can be easily coupled to sustainable materials plastic/paper-based platforms to build affordable /efficient and ubiquitous biosensing devices.

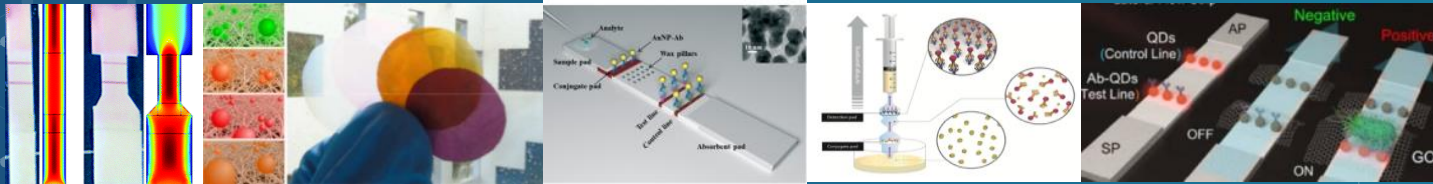
Paper / nanopaper / graphene exhibit unprecedented properties as either electrical or optical transducer for Biosensing applications

Their properties and related platforms can enable:

- Connection to a variety of (bio)receptors and nanomaterials
- Simple assay procedures and avoid time consuming labours
- Compatibility with mobile phone technology

Can be used in various diagnostics areas

- Health care and disease screening
- Food testing
- Security
- Environmental safety



OUR GROUP



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@merkoci_group



Merkoçi Research Group

Trustees:

Member of:

Thank you very much!

QUESTIONS?

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