MAY 06, 2020
CONFERENCE ONLINE

BIOSENSORS FOR PANDEMICS

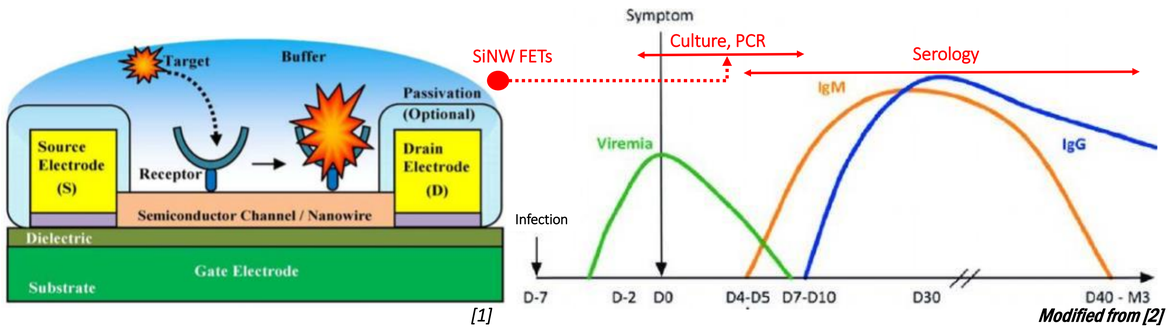
Silicon nanowire-based field-effect transistor array for multiple and rapid pathogen detection

Bergoi Ibarlucea[1], Taiuk Rim[2], Larysa Baraban[1,#], Gianaurelio Cuniberti[1]
[1]Institute for Materials Science and Max Bergmann Center for Biomaterials, Center for advancing electronics Dresden (cfaed), Dresden University of Technology, Dresden
[2]Department of Creative IT Engineering, Pohang University of Science and Technology, Pohang, Republic of Korea
[#]Present address: Helmholtz Center Dresden Rossendorf, Institute for Radiopharmaceutical Cancer Research, Bautznerlandstrasse 400, Dresden

Motivation

•**Multiple diseases** produced by different pathogens show **similar initial symptoms**: fever, vomits, diarrhea...

•In fast spreading pandemics, **PCR** diagnostics **is slow** and **detection of immune reaction can be late.**
•Early and **direct detection of the antigen** or the toxins would allow taking **more immediate actions.**
•Silicon nanowire-based field-effect transistors (**SiNW FETs**) **are ultrasensitive** devices compatible with microsystem technologies for mass production of devices containing **sensor arrays**



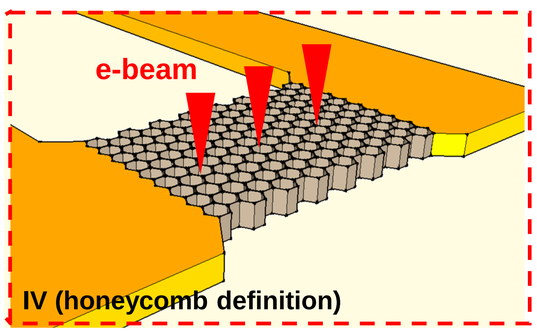
[1] *Modified from [2]*

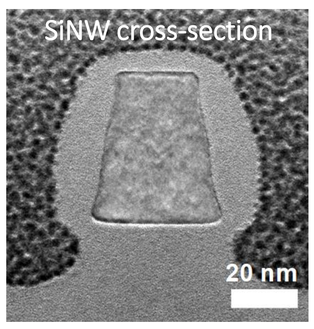
Objective: functionalization of SiNW FETs with antibodies for detection of and discrimination of the lethal Ebola disease from others causing similar initial symptoms.

Sensor fabrication and functionalization

Design and fabrication

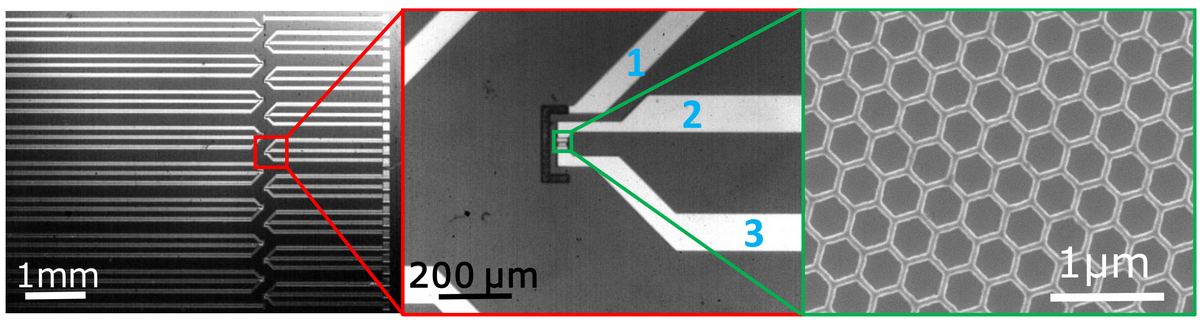
•Honeycomb structure patterning (HC-FET) by electron beam lithography
•16 FETs aligned for microfluidic integration

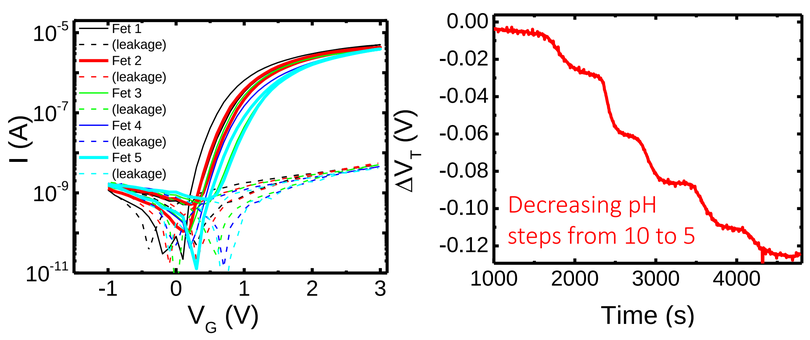




[3, 4, 5]

➢ High mechanical robustness, improved electrical performance and large surface area

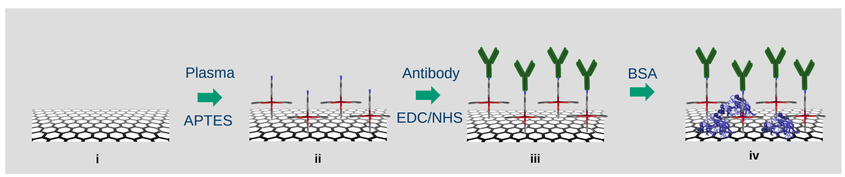




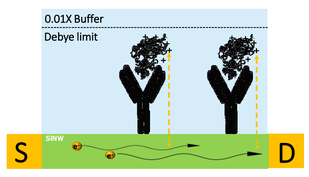
➢ n-type FETs, with threshold voltaje (Vt) negative shift with positive charges

Functionalization

•Silane based covalent crosslinking of antibodies for:
➢VP40 matrix protein of Ebola virus (40% of the viral protein mass)
➢ Cholera toxin subunit B
➢ Staphylococcal enterotoxin B (SEB)



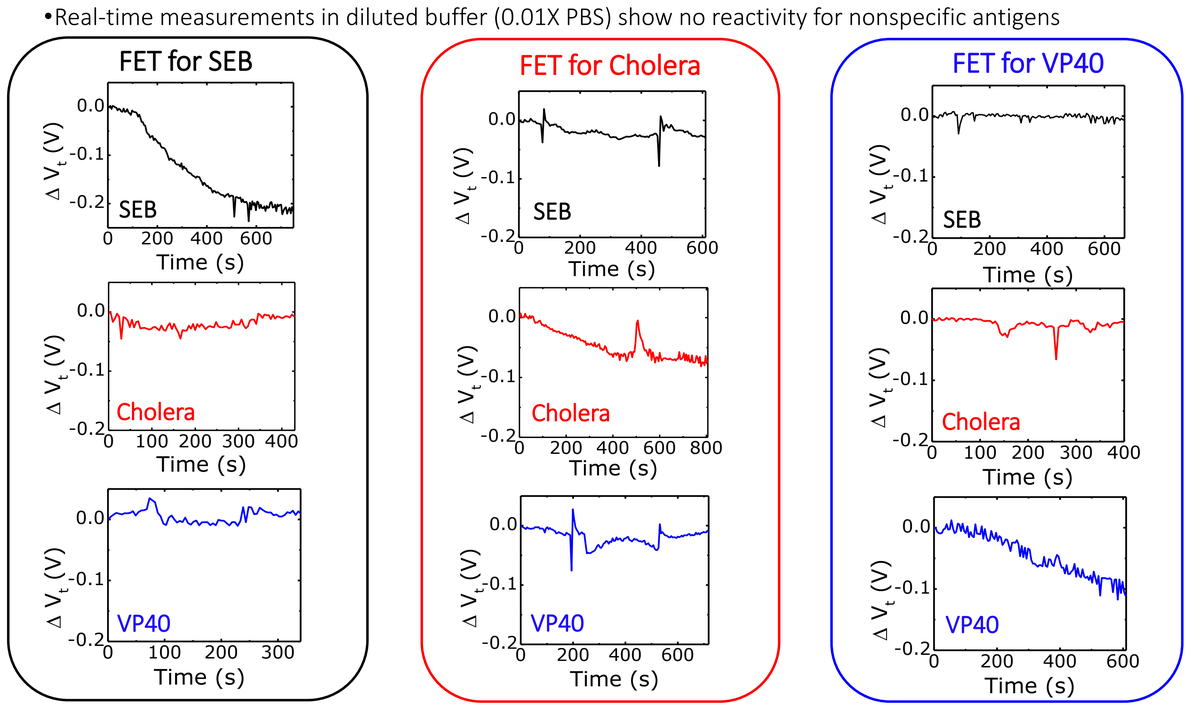
•Antigens attaching to antibodies will modulate FET conductance in diluted media



Biosensing

Selectivity

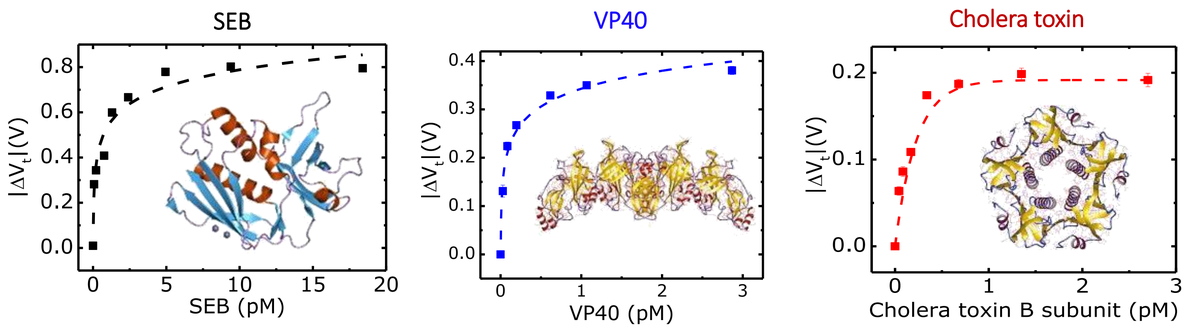
•Real-time measurements in diluted buffer (0.01X PBS) show no reactivity for nonspecific antigens



*500 fM antigen in all cases

Calibration

•Detection in femtomolar range and saturation in picomolar range



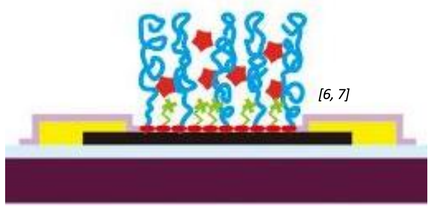
•Comparative table with state-of-the-art

Technique	Ebola detection	Miniaturization	Drawback
ELISA	nM	✗	Labeling
RT-PCR	10^3 pfu/mL	✗	Error amplification, labeling, duration…
TEM	10^6 VP/mL	✗	Special equipment
Plaque assay	10^1 pfu/mL	✗	Safety, duration
Flow cytometry	10^5 pfu/mL	✗	Labeling
SPR	10^6 pfu/mL	✓	-
SAW	10^4 pfu/mL	✓	-
FET	fM	✓ ✓	-

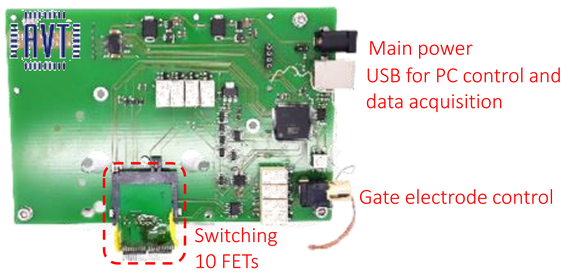
Conclusions and outlook

SiNW-FETs could enable rapid testing of pathogens in pandemic situation via direct antigen detection

•Dielectric polymers on surface will allow measurements in undiluted buffer



•Packaging with multiplexer will allow real time measurement of the array



Bergoi Ibarlucea
(bergoi.Ibarlucea@tu-dresden.de

REFERENCES

1. K.I. Chen et al., *Nano Today* 6(2), **2011**, 131-154
2. M.E. Álvarez-Argüelles et al., in Current Topics in Neglected Tropical Diseases IntechOpen, **2019**, 375-385
3. T. Rim et al., *Nanotechnology* 25, **2014**, 505501
4. B. Ibarlucea et al., *Lab Chip* 17, **2017**, 4283-4293
5. B. Ibarlucea et al., *Nano Research* 11, **2018**, 1057–1068
6. Gao et al., *Nano Lett*. 15(3), **2015**, 2143–2148
7. Gutiérrez-Sanz, *ACS Sens* 2(9), **2017**, 1278–1286

complex nano materials

BIOSENSORS FOR PANDEMICS
MAY 06, 2020 CONFERENCE ONLINE