



# Annual PhD Report "First Year"

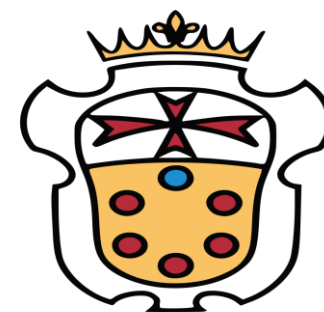


Presenter:

Mahdi Asgari

Supervisor:

Prof. Miriam Serena Vitiello



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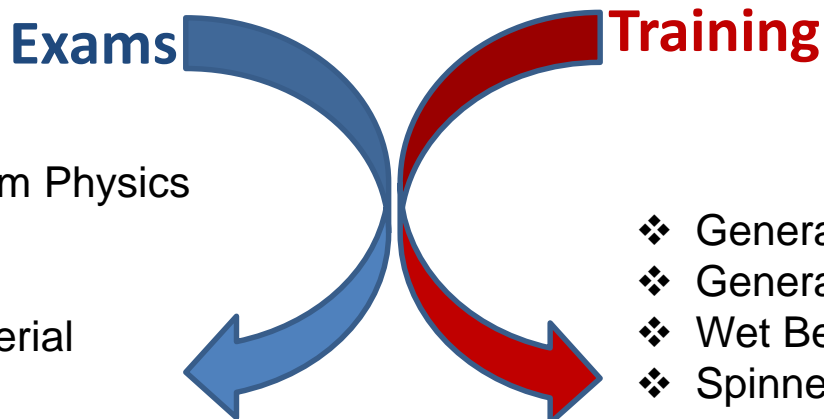
**October 2019**

National Enterprise for nanoScience and nanoTechnology

# NEST



**Attended courses,  
Passed exams,  
General and specific trainings:**



- Introductory Quantum Physics
- Nanostructured Material
- Condensed Matter Physics
- 10 Hours Intensive Italian Language Course
- Course on Health and Safety

- ❖ General Training for Clean-Room
- ❖ General Training for Photonic Lab
- ❖ Wet Bench
- ❖ Spinner
- ❖ Profilometer
- ❖ Oxygen-Plasma Etching
- ❖ Reactive Ion Etching (RIE)
- ❖ Sistec Evaporator
- ❖ Scanning Electron Microscope (SEM)
- ❖ Electron Beam Lithography (EBL)
- ❖ Leica Optical Microscope
- ❖ Bonder

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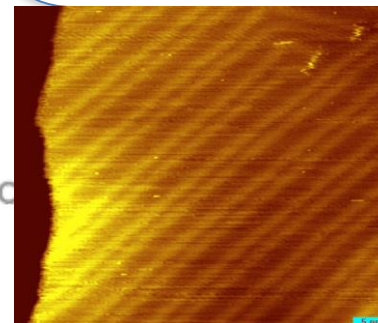
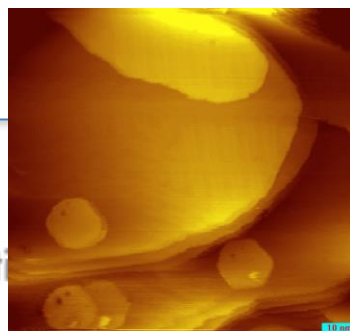
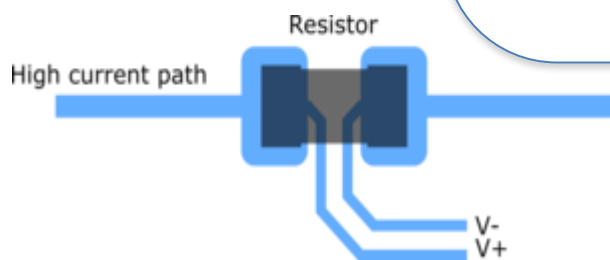
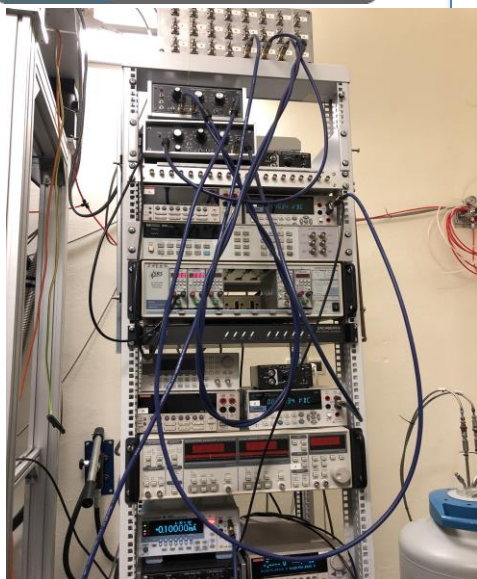
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## Stages:

### *Prof. Giazotto's group:*

4T sensing is an electrical impedance measuring technique that uses separate pairs of current-carrying and voltage-sensing electrodes to make more accurate measurements than the simpler and more usual two-terminal (2T) sensing. Four-terminal sensing is used in some ohmmeters and impedance analyzers, and in wiring for strain gauges and resistance thermometers.



### *Prof. Veronesi:*

STM analysis of nanostructures. The flat terraces of reconstructed gold are shown in the images. The inset and the zoom show the herringbone reconstruction, designed by the boundaries between the two possible crystalline structures: face centered cubic and hexagonal close packed.

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# TeraApps



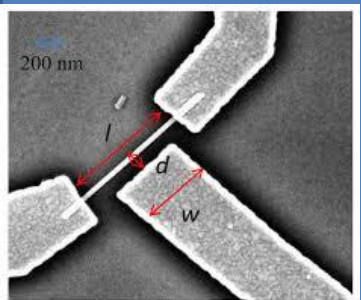
CNR NANO

PISA NEST

PhD Title:

## Development of Room-Temperature Terahertz Nano-Detectors

- Transferrable skills meeting\_ Glasgow\_ January 2019
- Introductory course on Terahertz technology and applications\_ London\_ April 2019
- ITSS summer school (Microwave and THz technology)\_ Frankfurt\_ July 2019

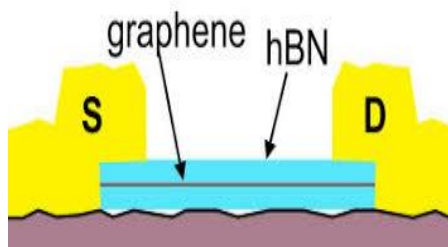
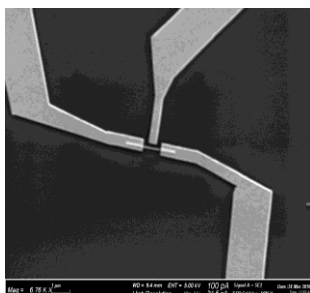
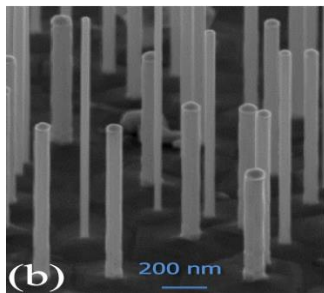


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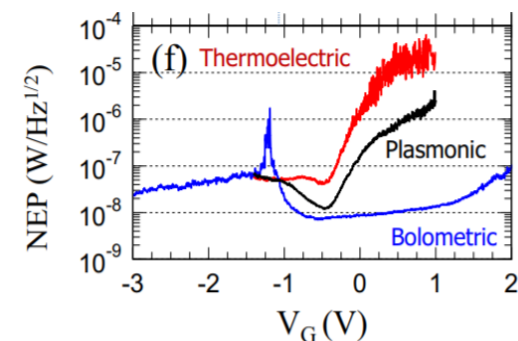
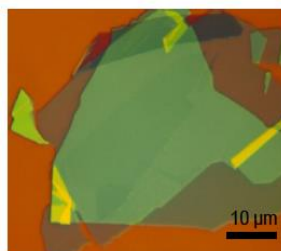
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## Foreseen Research:

1) Development of semiconductor quantum dot nanowire THz photodetectors.



Optical



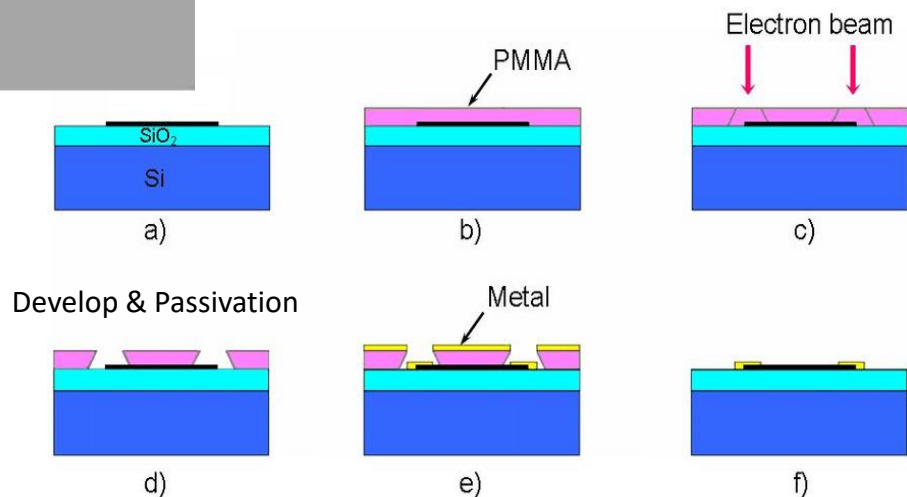
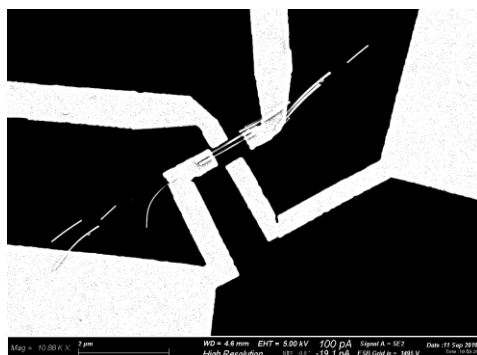
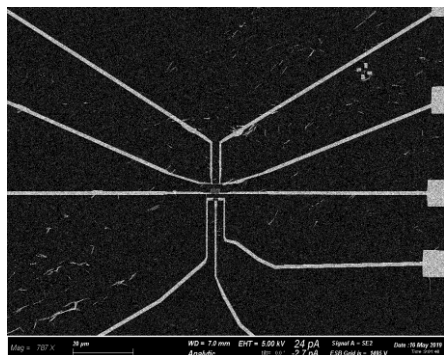
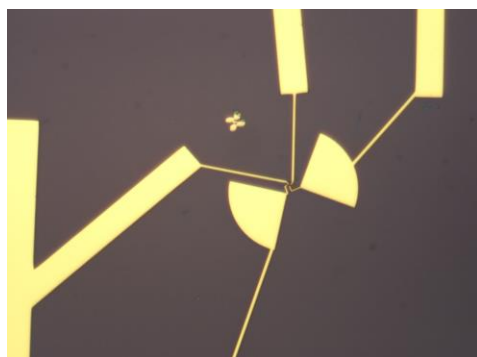
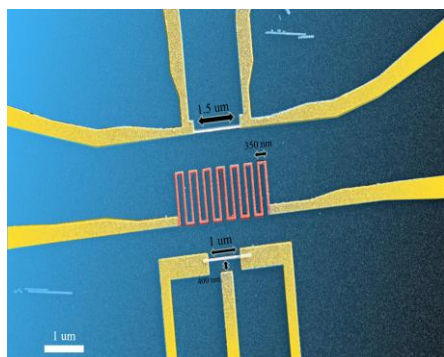
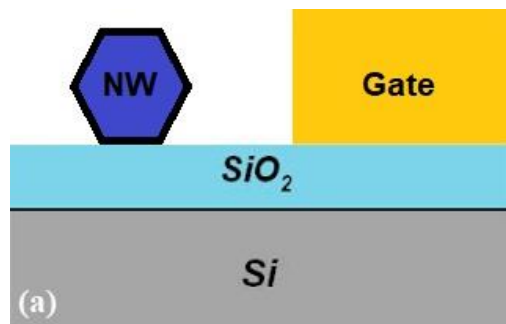
- Photo-thermoelectric effect
- Plasma-wave rectification
- Bolometric effect
- Photovoltaic effect

Viti L. et al., *Scientific Reports* 2016

2) Development of THz plasmonic or thermoelectric detectors based on new layered materials (especially graphene).

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**Fabrication process objective I**  
quantum dot nanowire THz photodetectors

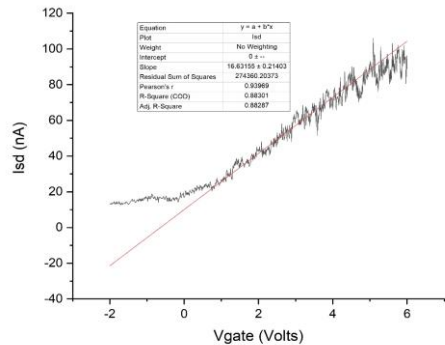
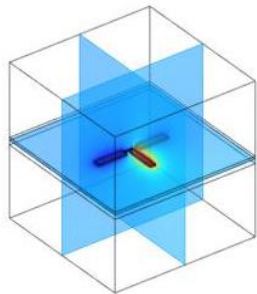
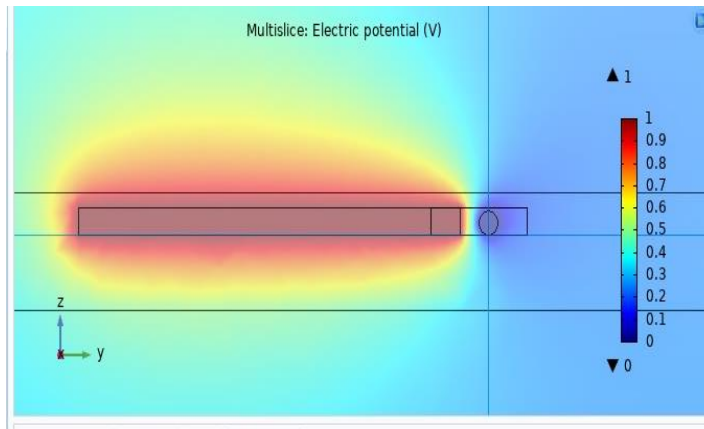


- a. Spin Coating:
- b. Electron Beam Lithography (EBL):
- c. Developing:
- d. Passivation-solution:
- e. Metal Evaporation:
- f. Lift-off Process:

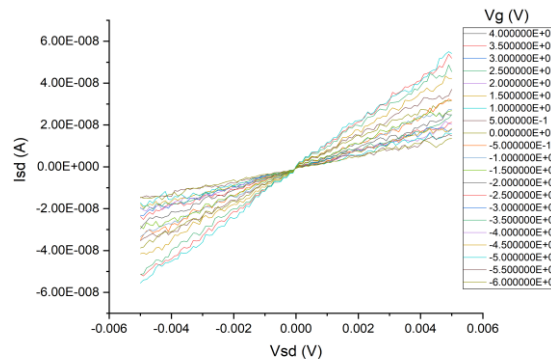
rise for nanoScience and nanoTechnology



**First measurements and results:**



$I_{sd}$  Vs.  $V_g$



No Current Leakage

$$g_m = \left( \frac{dI_{SD}}{dV_G} \right)_{\max} = 17 \times 10^{-9} \text{ A/V}$$

$$\mu = \frac{g_m W_g^2}{C_{WG} V_{SD}} = 2.5 \times 10^3 \frac{\text{cm}^2}{\text{V Sec}}$$

$$n = (\mu e \rho)^{-1} = 2 \times 10^{17} \frac{1}{\text{cm}^3}$$

$R_{nw} = 15.4 \text{ K}\Omega$

$V_{th} = -0.3 \text{ V}$



*Thank you for the attention*

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