

# Superconductors and wide-bandgap semiconductors

## Thesis activities at the Solid State Physics Research group



The screenshot shows the homepage of the Solid State Physics group website. The header includes the University of Torino logo, the group name, a physics department logo, and a QR code. A navigation bar lists: PEOPLE, RESEARCH, PUBLICATIONS, TEACHING, GRADUATES, THESES, SEMINARS, NEWS. The main content area is divided into two columns. The left column contains an 'Introduction' section with text about the group's history and research focus, followed by a list of research topics. The right column contains a 'Links' section with various institutional links. Below these is a 'Latest publications' section listing recent papers with authors and journal titles. At the bottom, an 'Upcoming Events' section details a series of colloquia organized by the group.

**Solid State Physics group**

Home | Contact |

PEOPLE | RESEARCH | PUBLICATIONS | TEACHING | GRADUATES | THESES | SEMINARS | NEWS

### Introduction

Under the guidance of Prof. Claudio Manfredetti, the Solid State Physics group of the University of Torino, Physics Department, started its activity in the early 1980s in the field of amorphous (a-Si:H) and crystalline (e.g. Si, CdTe) semiconductor materials, mainly for the fabrication of solar cells and ionization radiation detectors.

In the course of these three decades, the group has gradually extended its field of interest to the study of micro/nano-structured materials and devices and to the development of new experimental techniques for the characterization and modification of advanced materials and/or art objects.

Now, the group is working on the following main research topics:

- Semiconductor materials and basic devices: functional characterization by means of MeV Ion Beam techniques
- The physics of diamond: characterization, and selective modification at the nano/micro scale; applications in bio-sensing and quantum optics
- Production and characterisation of high and medium critical temperature superconducting materials
- Nanostructured materials
- Physics applied to cultural heritage

### Links

- University of Torino
- Physics Department
- Natural Sciences School
- NIS Interdepartmental Centre
- Solid State Physics Laboratory
- UniTo Phonebook
- Room Booking

### Latest publications

L. Guidorzi, A. Re, F. Picollo, P. Aprà, F. Fantino, L. Martire, G. Artoli, L. Peruzzo, S. Boesso, V. Rigato, L. La Torre, A. Lo Giudice, "Multi-technique study of He<sup>+</sup> micro-irradiation effects on natural quartz crystals contained in archaeological pottery", *Nuclear Instruments and Methods in Physics Research B* 479: 143-149 (2020)

B. Kuhn, F. Picollo, V. Carabelli, G. Rispoli, "Advanced real-time recordings of neuronal activity with tailored patch pipettes, diamond multi-electrode arrays and electrochromic voltage-sensitive dyes", *European Journal of Physiology* (2020)

E. Bernardi, E. Moreva, P. Traina, G. Petrini, S. D'Italia Tedeschi, J. Fornieris, Z. Pastusovic, I. P. Degiovanni, P. Olivero, M. Genovesi, "A biocompatible technique for magnetic field sensing at (sub)cellular scale using Nitrogen-Vacancy centers", *EPJ Quantum Technology* 7, 13 (2020)

### Upcoming Events

**From 30 march 2020**

To update the group on progress in our research lines, and to react to the possible depression induced by the forced stop of our scientific activities caused by the health emergency, the **solid state physics group** organizes a series of brief colloquia (30 min), given by the group members or from researchers of other institutions on topics spanning from material science, to quantum technologies, from biosensing, to cultural heritage.

**Seminars** will be given in English and addressed to a non-specialist audience; thesis, graduate and undergraduate students are welcome.

Colloquia are conducted through the **Webex platform**; the calendar of the seminars with the links to connect to the virtual room are available in the table herebelow.

<http://www.solid.unito.it>



Topic:

X-ray nanopatterning of oxide materials for novel electronics

Approaches:

photolithography, Metal-Jet X-ray source, setup development, X-ray focussing,  $\text{TiO}_2$  single crystal patterning, X-ray nanobeams, synchrotron radiation, X-ray absorption spectroscopy

In collaboration with:

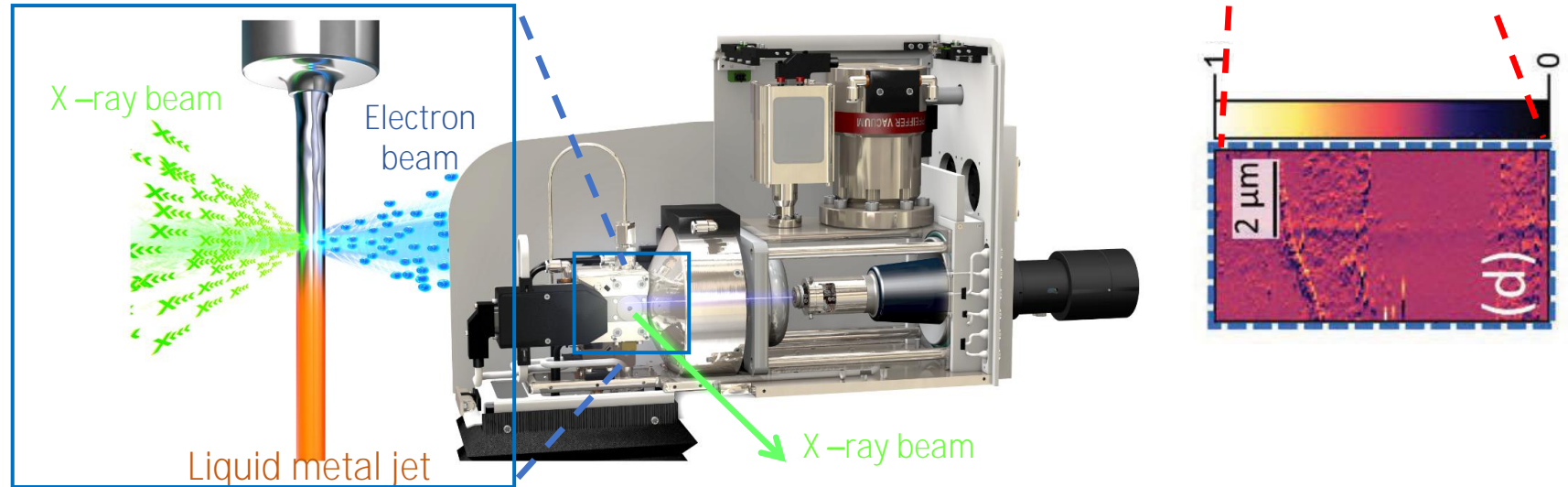
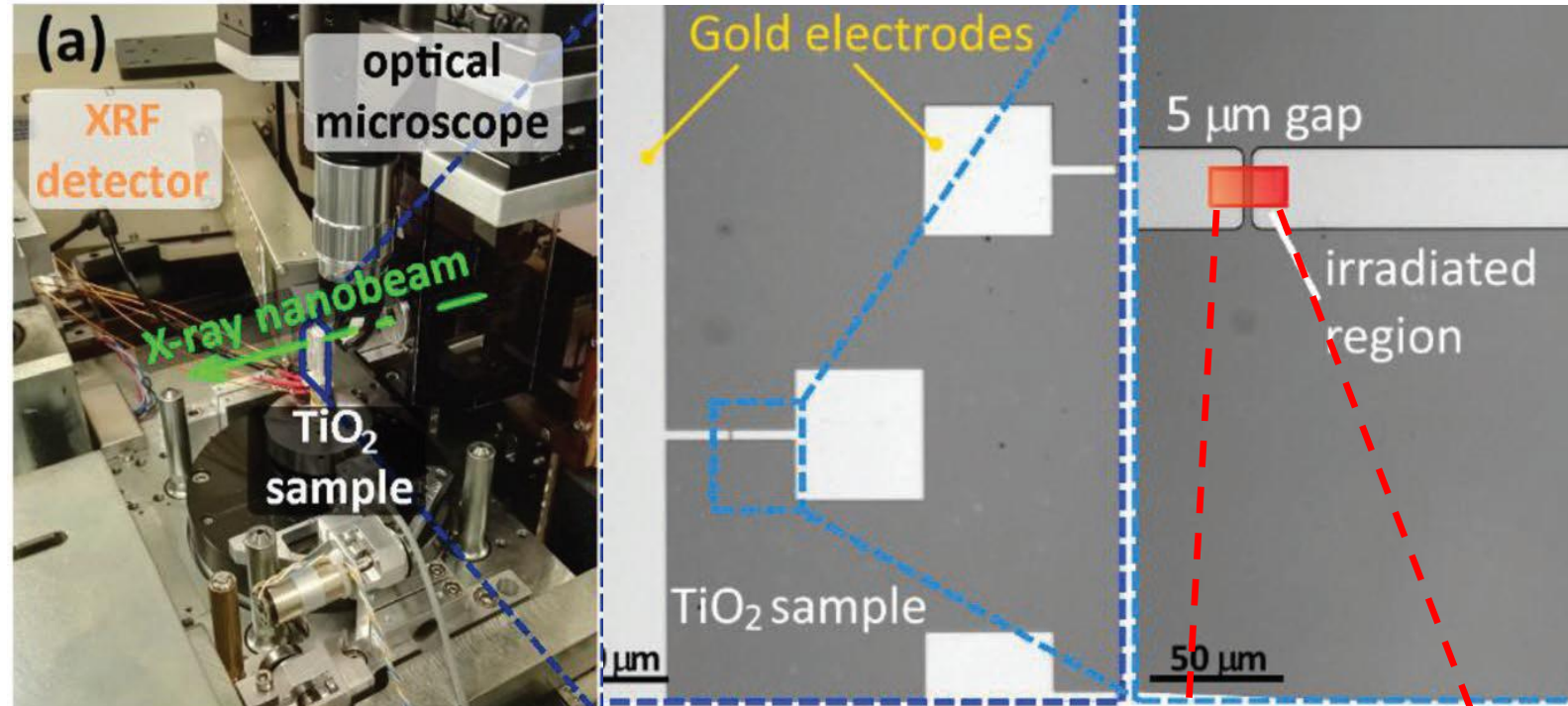
Chemistry Department

European Synchrotron Radiation Facility

Supervisor: Marco Truccato

Available from: To be negotiated

Turning an electrical insulator into a conductor



Topic:

Effects of focussed X-ray beam on high-Tc superconductors

Approaches:

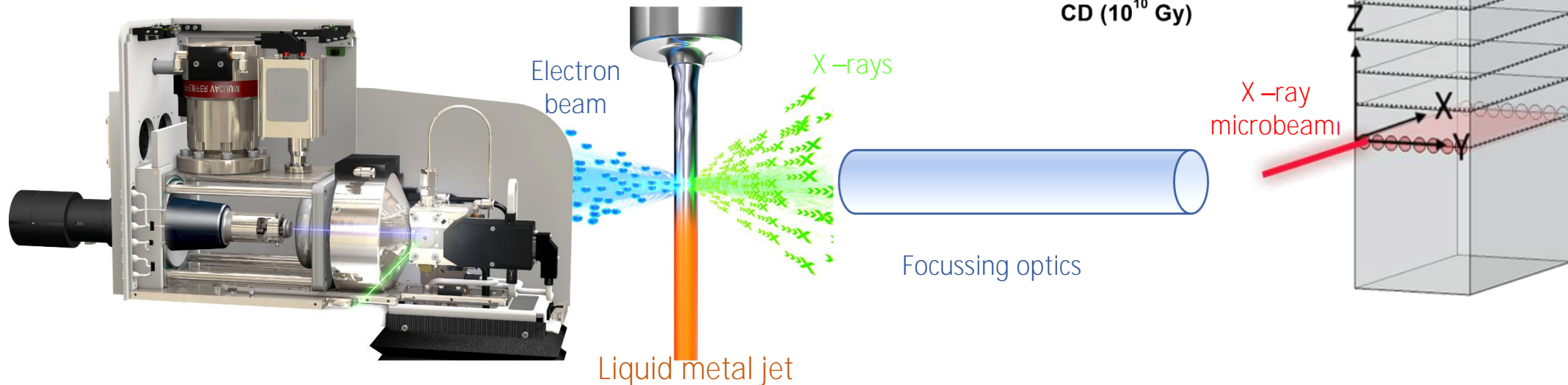
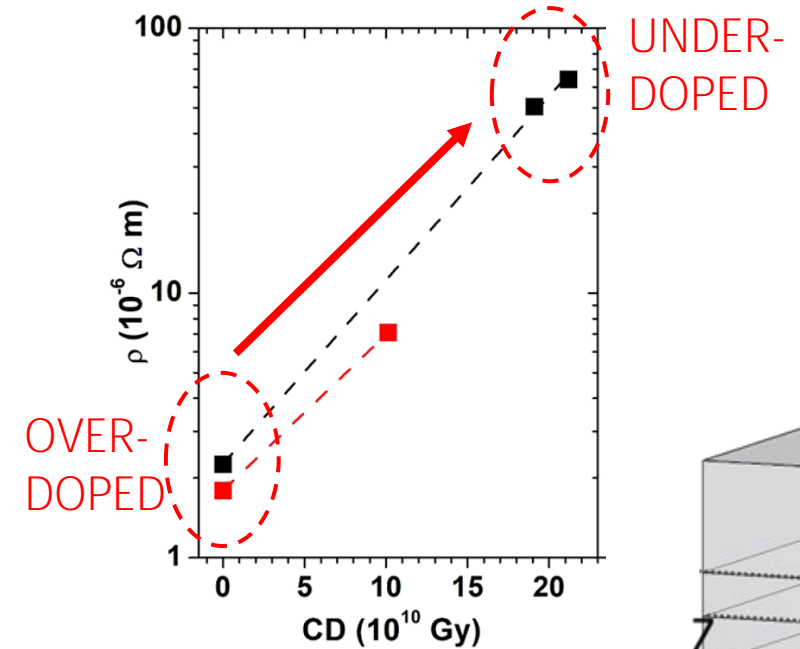
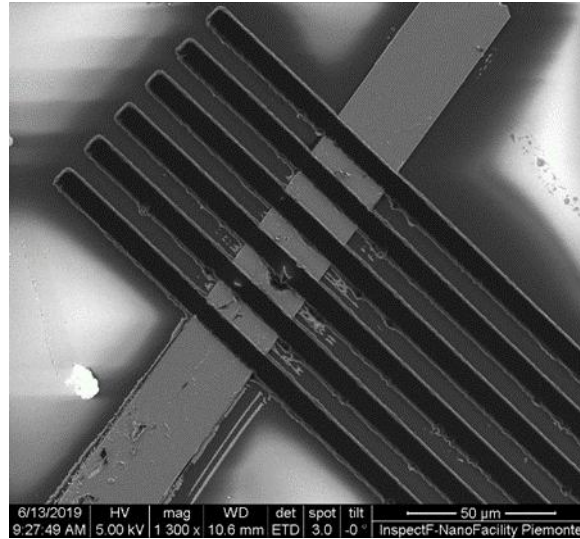
photolithography, Metal-Jet X-ray  
source, setup development, X-ray  
focussing, synchrotron radiation,  
numerical simulations

In collaboration with:  
Chemistry Department

Supervisor: Marco Truccato

Available from: To be negotiated

Inducing underdoping in Bi-2212 via X-ray irradiation  
Is it possible to reproduce synchrotron effects on the lab scale ?





Topic:

MgB<sub>2</sub> as a novel antimicrobial material

Approaches:

Material synthesis and characterization, reactive liquid infiltration, antibiofilm activity, X-ray diffraction, Rietveld refinement, medical applications

In collaboration with:  
Chemistry Department  
Romania National Institute for Physics of Materials



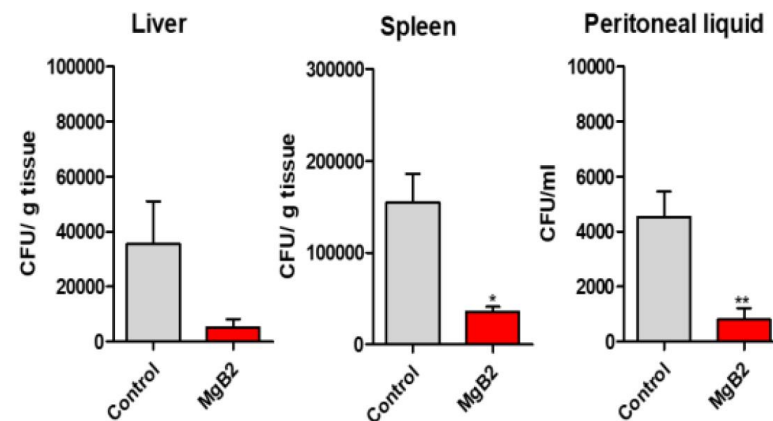
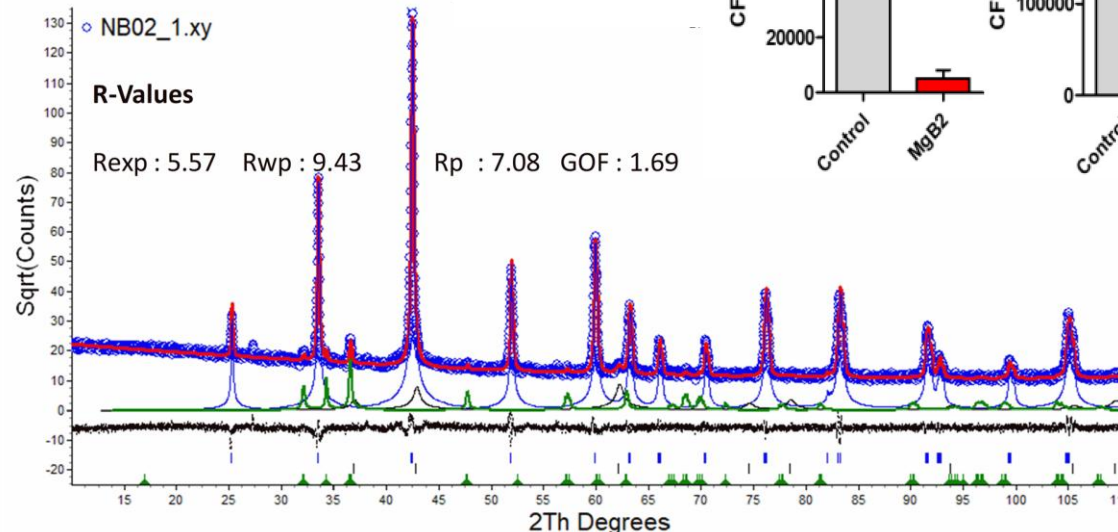
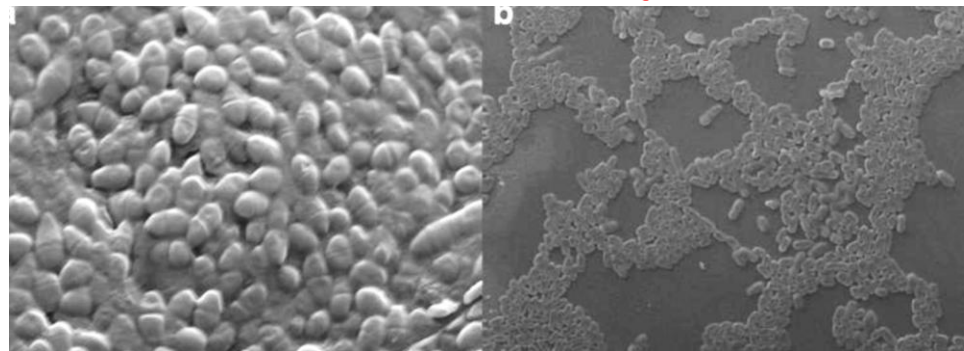
Part of a EU project: BIOMB



Supervisor: Marco Truccato

Available from: To be negotiated

Antibiofilm activity



# Novel classes of diamond quantum emitters

Supervisor: Jacopo Forneris

Available from: to be negotiated

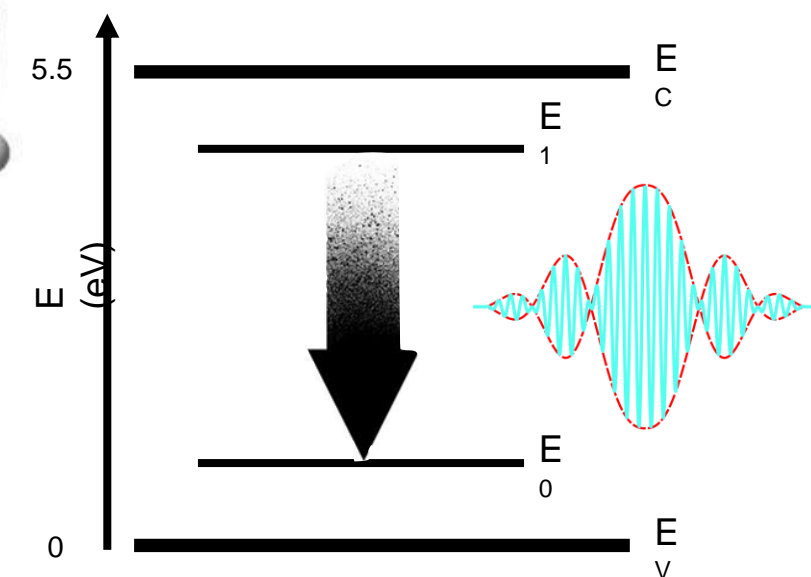
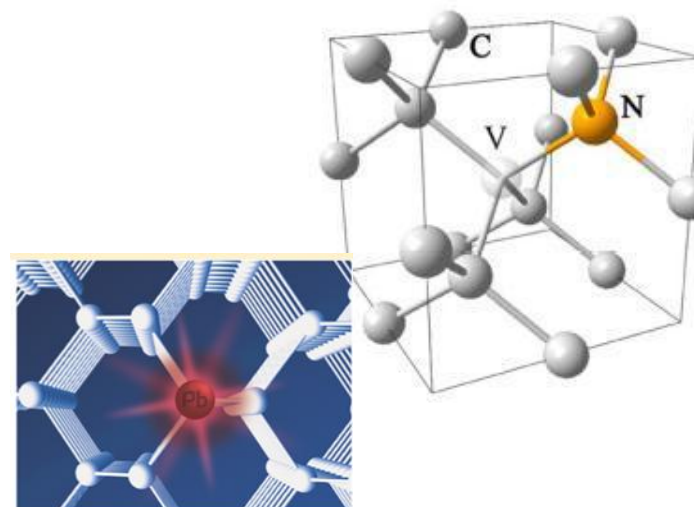
Approaches:

## Experimental activity

## Optically-active defects: single-photon emission

Limited number of defects known

# Exploration of photoluminescence properties of ion implanted diamond



## Confocal microscopy apparatus: set-up (room temp., 4K) and operation

## Single-photon emission assessment by interferometry

## Thermal processing of diamond plates

Study of activation processes (thermal, laser annealing)

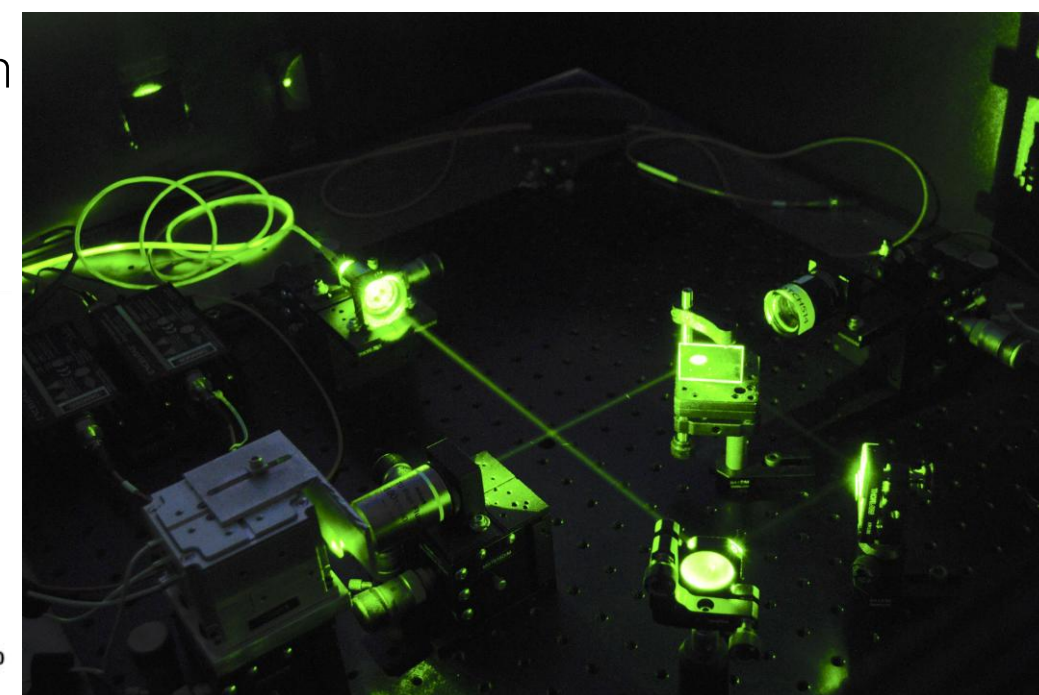
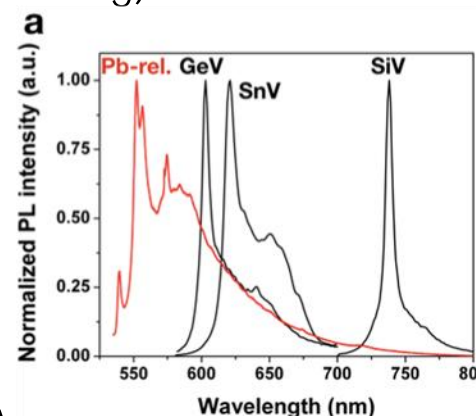
Alternative materials:

Si, SiC: IR confocal microscope, from Feb 2021

In collaboration with:

Istituto Nazionale di Fisica Nucleare (INFN)

Istituto Nazionale di Ricerca Metrologica (INRiM)



Legend:

- Red: INFN/UNIto
- Green: In fase di studio

Periodic table showing elements 1 through 86, color-coded according to the legend.

Part of a project:

EU SIQUEST research project



The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States



Topic:  
Electrical stimulation of diamond quantum emitters

Supervisor: Jacopo Forneris

Available from: to be negotiated

Approaches:  
Experimental activity

Optically-active defects: single-photon emission  
Exploration of electroluminescence properties of ion implanted diamond

Single-photon confocal microscopy  
Sample processing in cleanroom environment

Lithography techniques for electrodes fabrication

- ion implantation
- deep ion beam lithography
- focused ion beam (FIB)
- photolithography

Characterization of electrical structures

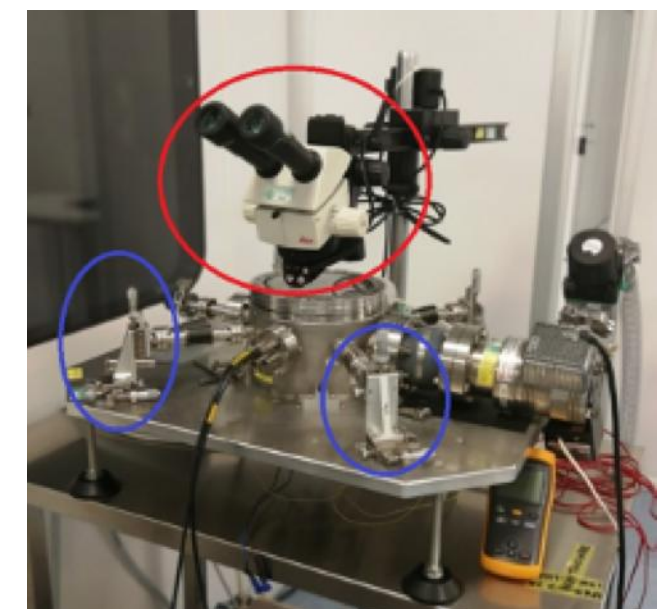
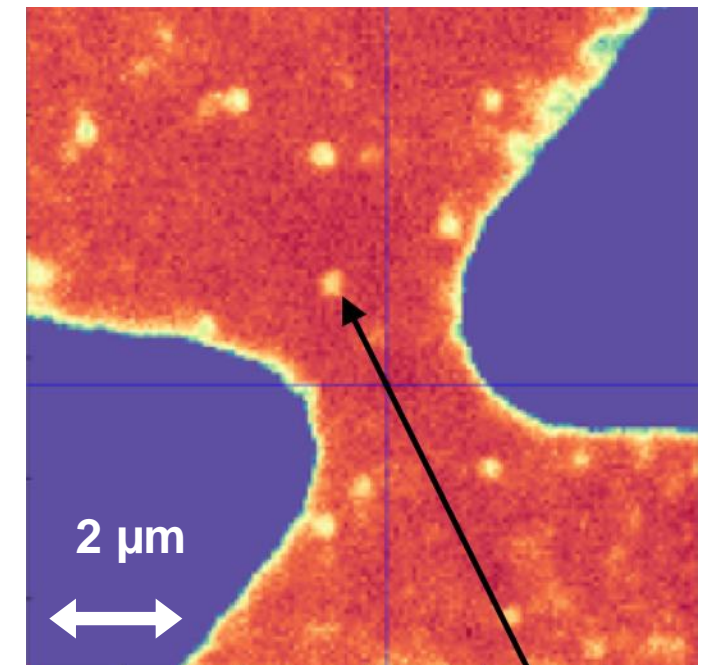
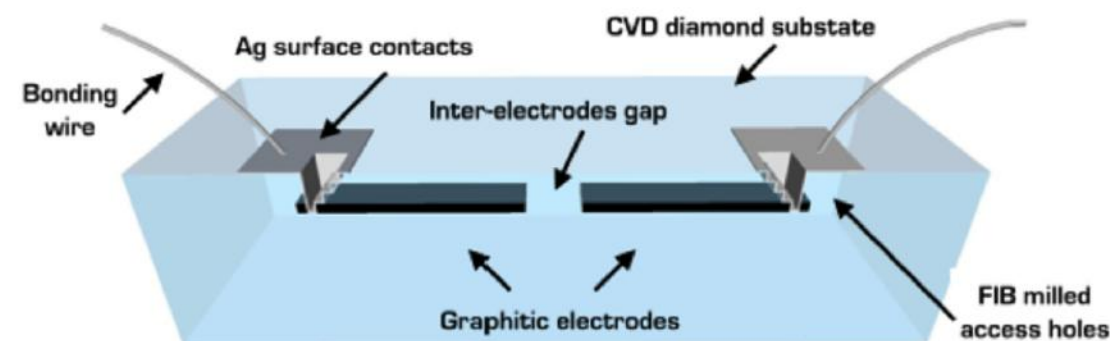
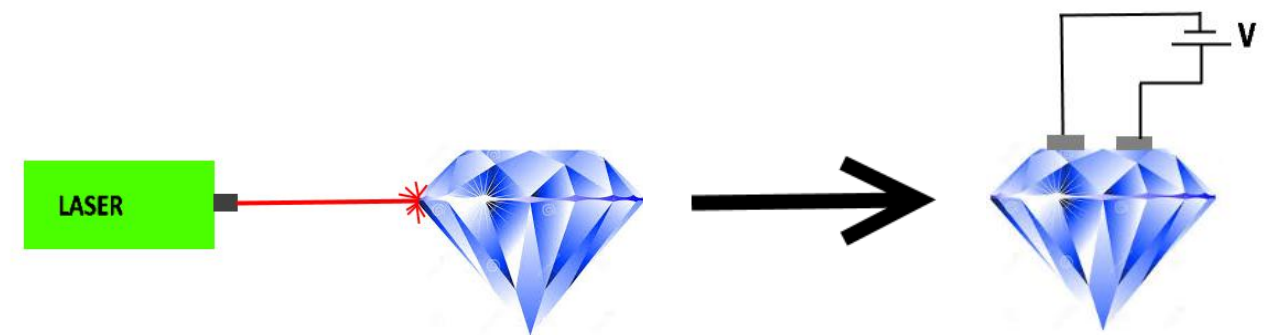
In collaboration with:

Istituto Nazionale di Fisica Nucleare (INFN)

Istituto Nazionale di Ricerca Metrologica (INRiM)

Part of a project:

EU SIQUST research project



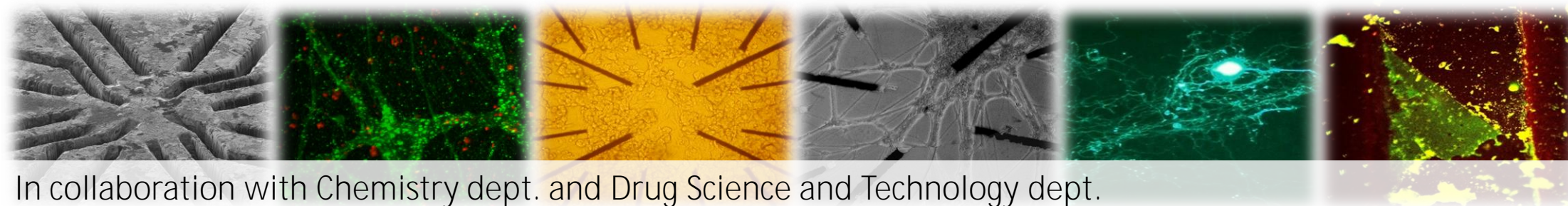
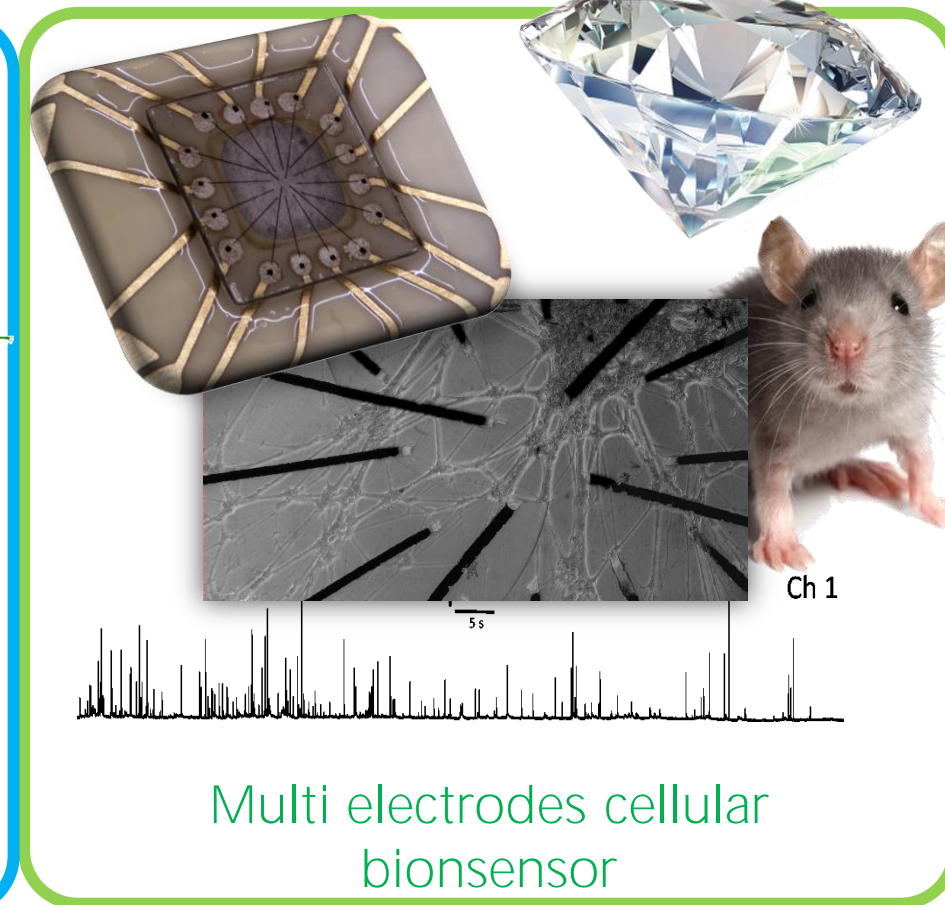
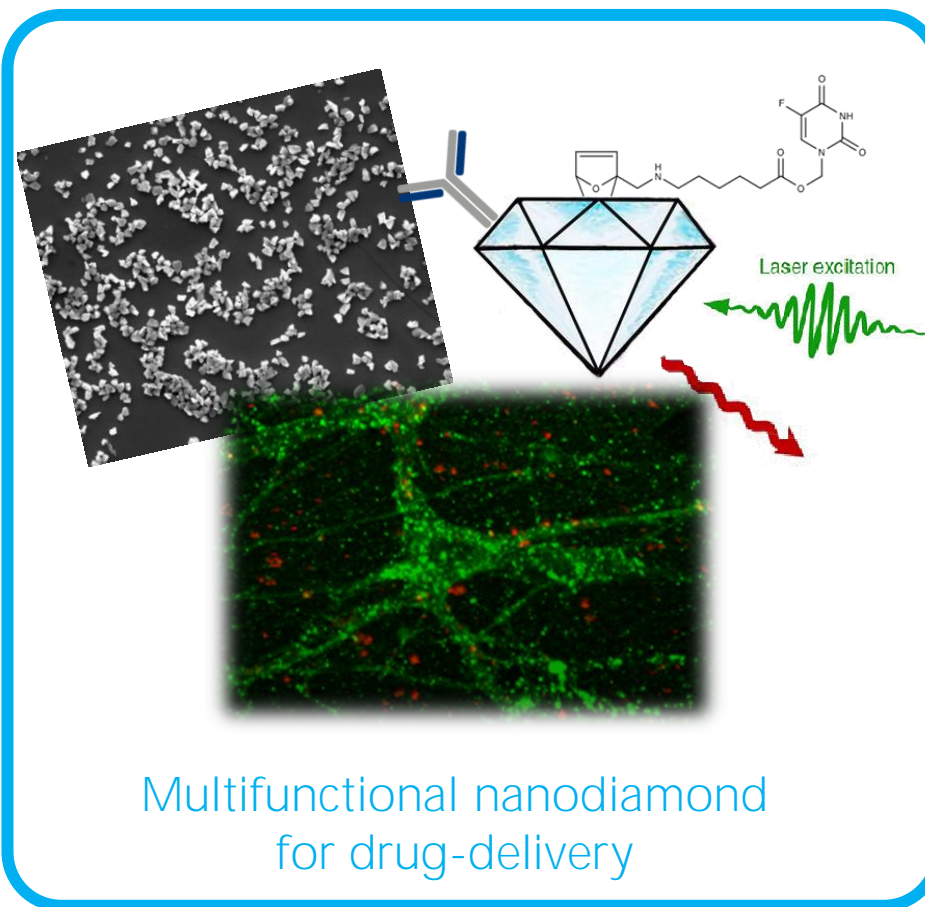


Topic: diamond, biosensing, nanoparticle, surface properties, drug delivery, radiobiology

Supervisor: Federico Picollo  
federico.picollo@unito.it

Available from: to be negotiated

Approaches:  
ion beam lithography, sensors and set-up development, amperometry, IR spectroscopy, material processing (thermal treatment), experiment with cells, X-ray irradiation, Raman and photoluminescence spectroscopy



Topics:

- Physical Metrology
- Nanosciences and Materials
- Metrology for Life Quality

Approaches: laser interferometry, mass spectrometry, magneto-fluxometry, micro- and nano-fabrication, materials modelling based on finite-elements and machine-learning methods, etc.

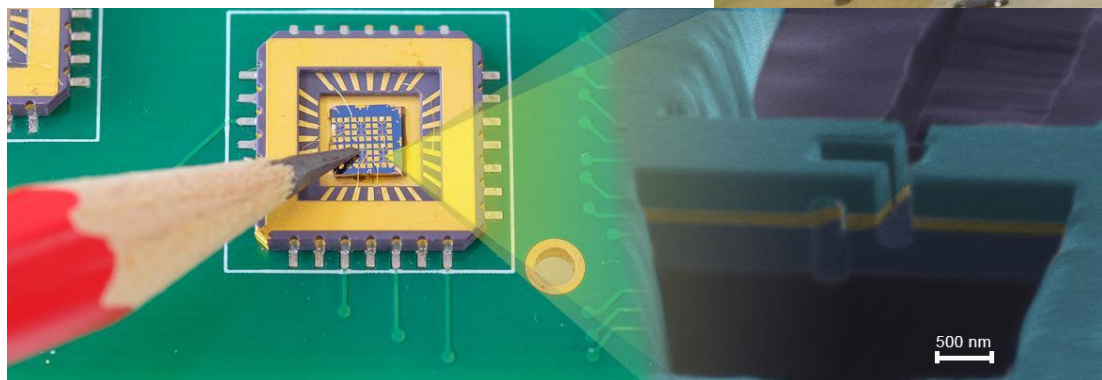
Supervisors: please contact  
Paolo Olivero

<https://www.inrim.it/>



Available from: to be negotiated  
with specific research group

<http://www.solid.unito.it/>



Thesis activities at the National Institute of Metrologic Research (INRiM)