



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II



Maria Alessandra Cutolo

Optoelectronic system for liquid phase
biopsy based on fiber optic technology

Tutor: Prof. Giovanni Breglio

Cycle: 36°

Year:2020/2021

My background

- **M.Sc. in Electronic Engineering – 12th July 2019**

Thesis title: "Lab-on-Fiber" thermo-plasmonic platforms for the localized release of drugs.

Tutors: Prof. Giovanni Breglio, Prof. Andrea Cusano (University of Sannio, BN).

- **Research contract by Cerict (BN) – July 2019 to July 2021:**

- Development of thermo-plasmonic platforms with a view to the localized release of drugs through microgel.
- Design of a needle as an ultrasound probe for selective and localized destruction of cancer cells.
- Design and development of a barcode and QRcodes for a low cost wireless sensor for structural, medical and environmental monitoring.
- Design of an innovative in-line control system for soft tissue and bone drilling.

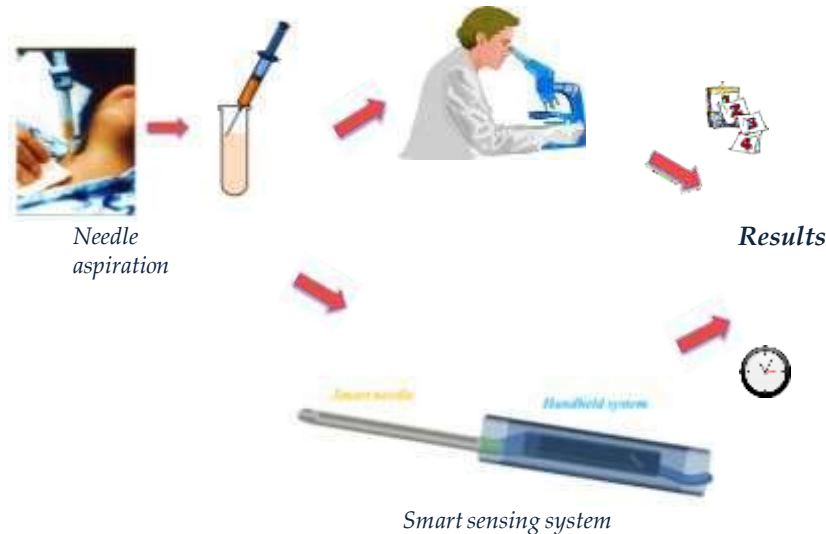
- **Ph.D. started in Nov 2020 (XXXVI cycle):**

Title: Optoelectronic system for liquid phase biopsy based on fiber optic technology

Tutors: Prof. Giovanni Breglio

Problem

- ❑ Thyroid carcinomas represent the most frequent malignant pathology of the endocrine system
- ❑ 3-5% of all human carcinomas
- ❑ For the treatment of thyroid cancer, surgery is the treatment of first choice.
- ❑ The surgeon tends to remove as few lymph nodes as possible.
- ❑ The choice is made during the surgery, by the eye surgeon.

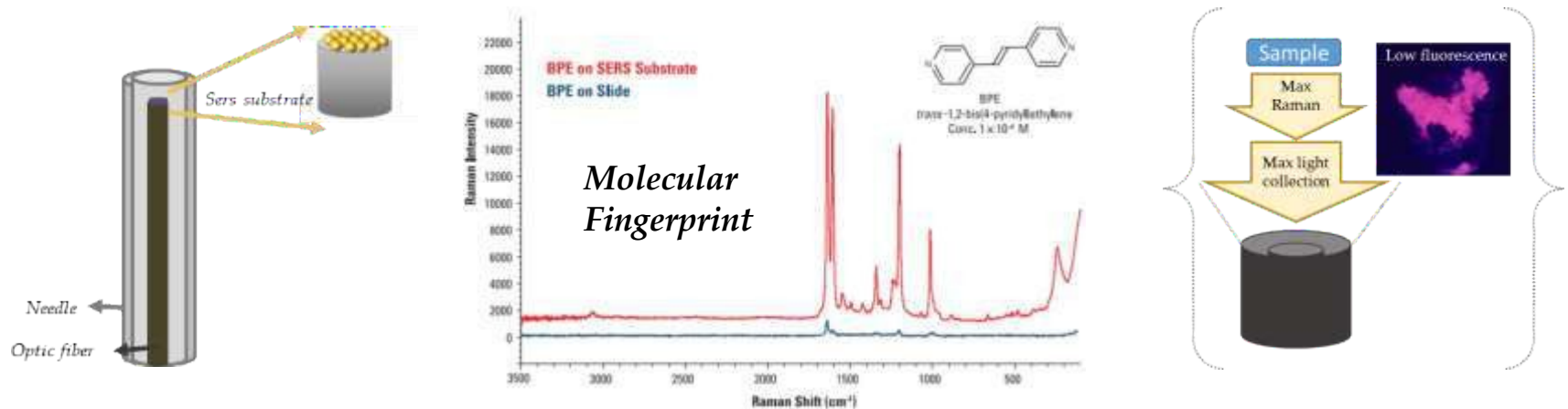


Research field of interest

This research doctorate deals with the design, implementation and validation of a fiber optic liquid biopsy system for early diagnosis of tumor pathologies.

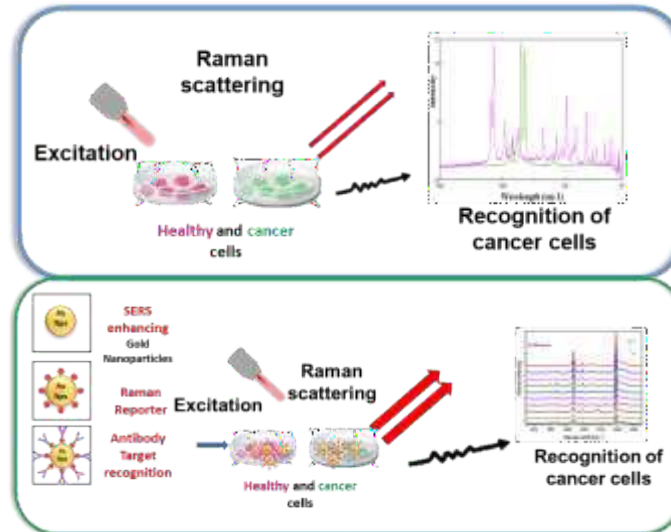
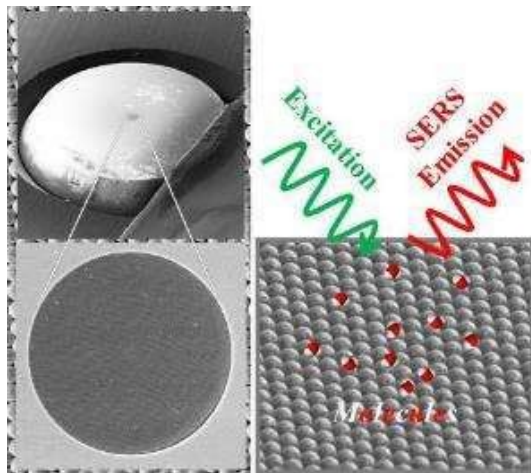


The system is based on nanofabrication of plasmonic surfaces (SERS substrate) at the tip of an optical fiber. The "Sers substrate" provide an amplification of different orders of magnitude of associated Raman signals to analytes located near a metal nanostructure.



Objective:

The *PhD* project goal is *the development of an innovative platform for Liquid Biopsy (LB)* based on optical fiber SERS *probes*, i.e. nano-scale sensing structures fabricated directly on *the tip of optical fibers* by advanced *Lab-on-Fiber technology*



Surface Enhanced Raman Spectroscopy (SERS) provides details on the molecular structure of sample analyzed

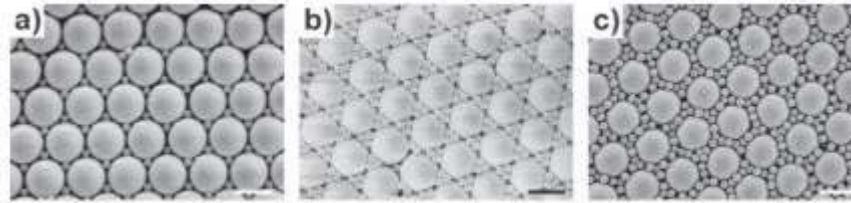
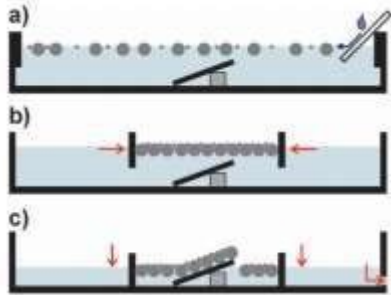
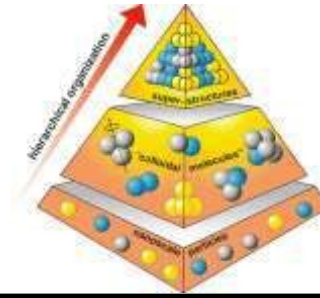
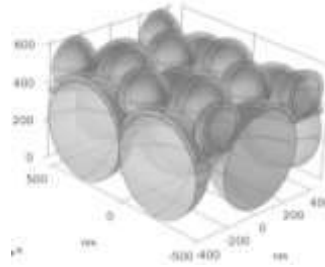
Lab on fiber technology allows the integration on fiber tip of nanostructures

The synergy between Lab on fiber technology and Raman analytical technique enables the realization of advanced Point of Care (POC) diagnostic devices



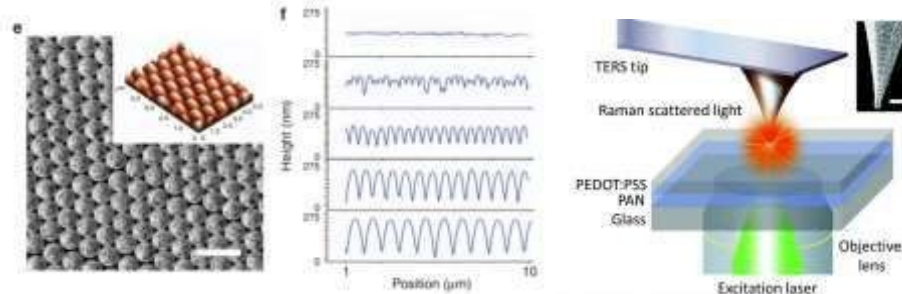
Methodologies:

Design of SERS substrate in *Comsol Multiphysics*



Fabrication through *self-assembly* methodology

Characterization with *AFM, SERS* and *TERS*



Research activity: Overview

Problem: identify the best geometry configuration for the SERS substrate

Objective: designing an innovative sensor with better performance than literature

Intended contribution: sensor design, analysis and testing

Summary of study activities:

	Courses	Seminars	Research	Tutorship	Total
Bimonth1	0	1.5	2	0	3.5
Bimonth2	0	2.2	8	0	10.2
Bimonth3	9	1.3	5	0	15.3
Bimonth4	0	0	8	0	8
Bimonth5	0	0	7	0	7
Bimonth6	14	0	5	0	19
Total	23	5	35	0	63
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

Courses

- Nanotechnologies for electrical engineering
- How to boost your PhD
- Circuiti e sistemi elettronici per applicazioni biomedicali.
- CI-LAM Summer School

Conferences

- *TTMeetUP 2020 (Fondazione R&I):*
Title: Barcodes and QRcodes for a low cost wireless sensor for structural monitoring, medical and environmental.
- *TTMeetUP 2020 (Fondazione R&I):*
Title: Thermo-plasmonic lab-on-fiber optrodes.

Products

Journal contributions

[P1]	Authors: Maria Alessandra Cutolo, Antimo Migliaccio, Lucia Altucci, Antonello Cutolo, Andrea Cusano. Title: An Innovative High Frequency Hyperthermia Approach against SARS-Cov-2 and Related Virus: Feasibility Analysis . Archives of Clinical and Biomedical Research 5 (2021): 421- 432.
[P2]	Authors: Sofia Principe, Martino Giaquinto, Alberto Micco, Maria Alessandra Cutolo, Michele Riccio, Giovanni Breglio, Andrea Irace, Armando Ricciardi, Andrea Cusano. Title: Thermoplasmonic lab-on-fiber optrodes , Optics & Laser technology, Volume 132, 2020, 106502, ISSN 0030-3992, https://doi.org/10.1016/j.optlastec.2020.106502 .
[P3]	Authors: Antonello Cutolo, Angelo Rosario Carotenuto, Maria Alessandra Cutolo, Arsenio Cutolo, Martino Giaquinto, Stefania Palumbo, Andrea Cusano, Massimiliano Fraldi. Title: Ultrasound waves in tumours via needle irradiation for precise medicine , Journal: Scientific Reports, Status: <u>under review</u> .
[P4]	Authors: Maria Alessandra Cutolo, Giovanni Breglio, Title: Interferometric Fabry-Perot sensors for ultrasound detection on the tip of an optical fiber , Journal: Results in Optic, Status: <u>submitted</u> .

Conference contributions

[C1]	TTMeetUP 2020 (Fondazione R&I) Title: Barcodes and QRcodes for a low cost wireless sensor for structural monitoring, medical and environmental . Authors: Cutolo Antonello, Cusano Andrea, Iele Antonio, Bruno Francesco, Cutolo Maria Alessandra.
[C2]	TTMeetUP 2020 (Fondazione R&I) Title: Thermo-plasmonic lab-on-fiber optrodes . Authors: Sofia Principe, Martino Giaquinto, Alberto Micco, Maria Alessandra Cutolo, Michele Riccio, Giovanni Breglio, Andrea Irace, Armando Ricciardi, Andrea Cusano.