BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

DISAT - Identification of Genetic Biomarkers of Disease by Surface Enhanced Raman Spectroscopy and Liquid Biopsy

Funded By	Dipartimento DISAT
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Context of the research activity	The detection of circulating disease biomarkers in bodily fluids, also known as liquid biopsy, has taken important strides toward the implementation of personalized medicine. However, it still suffers from low sensitivity and high costs, which render its clinical implementation not practical or affordable. In particular, the identification and quantification of oligonucleotide biomarkers is hampered by the need to employ sequencing tools that are expensive, require highly trained personnel, and are prone to error. Nonetheless, detecting cancerous or viral biomarkers is extremely important toward early diagnosis, which motivates the need for further research making the detection simpler, cheaper, and thus more widely available.
Objectives	By leveraging the intrinsic amplification capability of surface enhanced Raman scattering (SERS), in this PhD program the student will address the issues of low sensitivity and high cost by developing an innovative detection method that combines plasmonic nanoparticles synthesized ad hoc to maximize SERS signal amplification with direct SERS sensing for the rapid analysis of the complex spectral responses obtained by screening bodily fluids for specific genetic biomarkers of disease. The student will gain knowledge on nanotechnology, spectroscopy, plasmonics, and sensing, and will benefit from the exposure to a highly multidisciplinary and international team, in which he/she will also become proficient in the use of technical English for writing manuscripts and delivering seminars and presentations. The student will be responsible for: 1. The design of bespoke plasmonic nanoparticles for the optimization of SERS enhancement; 2. Understanding how to maximize the amplification of the SERS signal of DNA and RNA targets via direct interaction with the nanoparticles; 3. The identification and quantification of target genetic biomarkers of disease and determine the presence of mutations. In particular, the student will: 1. Design and characterize six-branched gold nanoparticles also leveraging

	automated approaches; 2. Design and optimize methods to stably and reproducibly adsorb DNA and RNA to gold nanoparticles so that their SERS signal is consistent across measurements; 3. Implement liquid-based measurements of the SERS response of DNA and RNA with rapid collection times and high spectral resolution; 4. Analyze the obtained SERS spectra with innovative statistical methods; 5. Understand how to efficiently extract and manipulate DNA and RNA from complex matrices that mimic bodily fluids; 6. Understand how to treat and minimize the background signal generated by the complex matrix during the SERS measurements; 7. Coherently organize and report the data collected for presentation to the other group members, collaborators, and/or audiences at conferences.

Skills and competencies for the development of the activity	We are looking for talented and driven students with preferably a M.S. degree in chemistry, materials science, or bioengineering (broadly defined) and previous expertise in: 1. Synthesis and functionalization of gold nanoparticles; 2. Basic knowledge of Raman and surface enhanced Raman spectroscopies; 3. Design and manipulation of nucleic acid probes; 4. Basic theoretical knowledge of nucleic acid amplification techniques (e.g., RT-PCR, LAMP).