Title of the doctoral program
Metrologia

Title of the research activity
Development of a Pulsed Coherent Raman Scattering Microscope for Non-Linear Optical Metrology

Short description of the research activity
The development of non-invasive diagnostic methods for regenerative medicine application based on non-linear optical microscopy techniques, such as Coherent Raman Scattering (CRS), Second Harmonic Generation (SHG) or Two Photon Excitation Fluorescence (TPEF), is one of the fundamental steps for the construction of a metrological methodology in stem cell analysis. Coherent Anti-Stokes Raman Scattering (CARS) microscopy, using picosecond laser pulses, was one of the first non-linear techniques implemented in biomedical studies, thanks to a relatively easy experimental scheme. However, despite CARS is a powerful diagnostic technique from a qualitative point of view (selective for a specific molecular target, tunable among different molecular targets and, above all, label-free) it is not very reliable for quantitative measurements because CARS signal has a squared dependence from the molecular concentration of the analyte. In contrast, Stimulated Raman Scattering (SRS) microscopy, possessing a linear response as a function of the concentration of the analyte, is a good candidate technique for a metrological study of stem cell differentiation, in which we want to quantify the production of biomarkers. The metrological methodology presupposes the definition of key measurable, the definition of specific measurement protocols and the definition of calculation of an associated uncertainty budget. In the field of regenerative medicine, and in particular within the framework of stem cell differentiation, the key measurable are identified as a series of specific substances (collagen for example), named "bio-markers", produced by stem cells only when the differentiation process is in place. Furthermore, we have to assure the non-invasiveness of the measurement technique: reducing the possible perturbation of the differentiation process increases the repeatability of measurements, allows you to get results "closer to the reality" and increases the confidence of your results. The aim of the project is to develop a non-linear SRS microscopy experiment, integrate the experiment within the existing setup: multimodal microscope already optimized for CARS, SHG and TPEF, and apply the new non-linear methods to the study of stem cell differentiation driven by the mechanical stimuli produced by specific scaffolds.


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Scientific sector (Settore Scientifico Disciplinare - SSD): ING-INF/07 (Chimica Fisica)
Number of international-review papers (last 5 years): 12
Total number of citations and source: 50 (Scopus)
h-index and source: 5

Type of research activity
The PhD candidate will perform experimental laboratory activity using picosecond pulsed laser source and microscope. Modeling, data analysis and image analysis activity is also present.

Site of activity
INRIM (Advance Materials Metrology and Life Sciences)

Active collaboration on the proposed research activity
Institutions with on-going cooperation:

- CNR-INO (Italy), LENS (Italy)
- Unit of Pathology, Candiolo Cancer Institute (FPO-IRCCS), Candiolo, Turin, Italy
- Department of Clinical and Biological Sciences, University of Turin, Italy;
- PTB, Berlin, Germany.
- Department of Chemistry (UNITO)

Specific requirements (experiences, skills)
Essential Requirements:
- Master Degree in Physics or Chemistry (Physical Chemistry, Spectroscopy) or Physical Engineering
- Good English (Written and Spoken)
- Ability to work in team.
Preferable Requirements:
- Experience with Laser, Laser Optics or Spectroscopy

Website of the research group (if any)