Curriculum Vitae Ai Fini della Pubblicazione

PROFESSIONAL EXPERIENCES

01/05/2021-31/10/2021: Visiting Scientist

Institution: Istituto Italiano di Tecnologia IIT, via Morego 30, Genova (GE)
Research: a pulsed laser source was used to perform two-photon polymerization under microfluidic flow of a poly(ethylene glycol) diacrylate (PEGDA) solution with the objective of realizing anisotropic micro-hydrogels carrying payloads of various nature, including small molecules and nanoparticles. The specific tasks of the role included: fabrication and design of microfluidic chips in clean room environment, optimization of the experimental set up designed for performing Two-Photon Continuous Flow Lithography, special insight on the characterization of laser signal, particle fabrication, particle purification methods, particle characterization through microscopic techniques.
Project: the project was partially supported by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement **no. 754490** (**MINDED**) and the Fondazione Istituto Italiano di Tecnologia
Scientific Director: Paolo Decuzzi
Protocol Number: IIT n. 0003369/21 del 28/04/2021

01/04/2021-30/04/2021: Internship

Institution: UCSC Università Cattolica del Sacro Cuore, Largo Francesco Vito 1, Roma (RM)
Research: study of exosome purification techniques finalized to minimize the contribution of impurities in Zeta potential measurements. Exosome characterization through Dynamic Light Scattering and Laser Doppler Electrophoresis. Study of biomechanical response of bowel cancer cells at different stages of the epithelial-to-mesenchymal transition through Atomic Force Microscopy measurements.
Scientific Director: Gabriele Ciasca

01/03/2021-15/06/2021: Teaching Activity (external collaborator)

Institution: associazione STEMUP, via A.Marzolo, 00122 Roma (RM)
Job Description: teaching of physics to a class of students, theoretical and practical explanation of physics to neurodivergent alumni.

01/10/2018-02/10/2019: Curricular Internship

Institution: La Sapienza Università di Roma, Piazzale Aldo Moro 5, Roma (RM)
Research: validation of innovative spectroscopic technique Laser Transmission Spectroscopy on liposomes and niosomes. Design, fabrication, drug loading, purification and characterization through Dynamic Light Scattering and Laser Doppler Electrophoresis of isoniazid loaded liposomes. Study of liposome encapsulation efficiency through fluorescent probe methods (fluorescence spectroscopy). Study of liposome encapsulation efficiency through UV-Vis quantification of isoniazid. Characterization of isoniazid loaded liposomes through Laser Transmission Spectroscopy.
Project: master's degree thesis, "Caratterizzazione LTS di nano-vescicole lipidiche per drug

delivery" (*"LTS characterization of lipid nanovesicles for drug delivery purposes"*)
Scientific Director: Federico Bordi

20/06/2016-20/10/2016: Curricular Internship
Institution: La Sapienza Università di Roma, Piazzale Aldo Moro 5, Roma (RM)
Research: review on the state of the art concerning the Cyclinac applications for hadrontherapy purposes.
Project: bachelor's degree thesis, "Cyclinac: un acceleratore per l'adroterapia" (*"Cyclinac: an accelerator for hadrontherapy purposes"*)
Scientific Director: Riccardo Faccini

EDUCATION

02/10/2019: Master's Degree in Physics
Thesis: *"Caratterizzazione LTS di nano-vescicole lipidiche per drug delivery" ("LTS characterization of lipid nanovesicles for drug delivery purposes"*)
Curriculum *in Physics of Biosystems*
Grade: *109/110*
released by La Sapienza Università di Roma

20/10/2019: Bachelor's Degree in Physics
Thesis: *"Cyclinac: un acceleratore per l'adroterapia" ("Cyclinac: an accelerator for hadrontherapy purposes")*
Curriculum *in Physics*
Grade: *99/110*
released by La Sapienza Università di Roma

12/07/2012: High School Diploma
Classical Studies
Grade: *96/100*
released by Convitto Nazionale "Vittorio Emanulele II", Roma (RM)

PROFESSIONAL SKILLS

Safety Qualifications
Enabled to work in areas characterized by chemical and biological hazard.
Enabled to work in areas characterized by laser radiation hazard.
Enabled to the use of the ISO6 and ISO7 clean room facility.
Graduated into the general training course for workers promoted by Confindustria Genova.

Optical Lab Skills
Long-time experience with optical setups thanks to the thesis research project and the experience as visiting scientist at IIT. Outstanding ability in laser beam characterization, design and maintenance of optical paths. Experience in the use and maintenance of highly reflecting mirrors, focalizing devices, choppers, photodetectors, ecc…
Main laser sources used:
- 5 ns Q-Switched Nd:YAG laser with variable wavelength (400-2600 nm) operating at 10 Hz repetition rate (NT342B Ekspla -Vilnius - LT) during master's thesis.
- Mai Tai femtosecond-laser (100 fs, 80 MHz) 800 nm at Istituto Italiano di Tecnologia.

Wet Lab Skills
Long-time experience in the use and safety standards concerning chemical and microbiological safety cabinets, technical gases, vacuum pumps, ovens, centrifuges, pH-meters, immersion and tip sonicators, stirrers. Handling and storage of hazardous substances (strong acids, liquid nitrogen). Long-time experience in the use of rotary evaporators. Expert in residual removal techniques and sterilization of spectroscopy cuvettes.

Spectroscopy Techniques
Spectroscopic characterizations represent the core of the techniques employed during the candidate's research work.

Dynamic Light Scattering (DLS) and Laser Doppler Electrophoresis were employed by the candidate for the first time during the curricular laboratory experience as part of the practical lab course. Both techniques were used for the study of the size distribution and colloidal stability of aggregates of polylysine decorated negatively charged liposomes. The two measurement methods were widely employed later during the curricular internship related to the master's degree thesis project. They were used to investigate the size distribution and colloidal stability of the liposome formulations employed in the study. DLS derived size distributions were compared with the ones obtained by Laser Transmission Spectroscopy. Dynamic Light Scattering and Laser Doppler Electrophoresis were extensively employed then during the internship at UCSC in the size distribution and Zeta potential measurements on samples of exosomes. Both the methods were always performed with a Malvern Multisizer instrument.

Laser Transmission Spectroscopy (LTS) is an innovative technique that allows to derive the number distribution of a sample of nano/microparticles in a solution as a function of their actual diameter from an experimental measurement of the extinction coefficient at different wavelengths. This technique requires the use of a variable wavelength laser source. LTS had been adequately validated on systems of full spherical nanoparticles, the subject of the candidate's master's thesis project was the validation of LTS on core shell structures like liposomes. The technique was also applied to characterize isoniazid loaded negatively charged liposomes.
Fluorescence Spectroscopy was widely employed during the master's thesis project to monitor the fluorescent dye leakage from calcein loaded negatively charged liposomes. Calcein was employed to mimic the behaviour of hydrophilic drug isoniazid. Thanks to the phenomenon of self-quenching at concentrations above 70 mM, the calcein inside the vesicles is not active. It starts exhibiting fluorescence when it permeates through the liposome membrane and dilutes in the bulk of the solution.

UV-Vis Spectroscopy was daily employed during the master's thesis project to quantify the drug

isoniazid in liposome samples. A C program was implemented by the candidate to derive from the pseudo-scattering signal of the vesicles the liposome's concentration in a solution thanks to a calibration method.

Liposome Preparation
Optimal knowledge of reverse phase liposome preparation techniques: reverse phase plus sonication, reverse phase plus freeze thaw method, reverse phase plus multiple extrusions. Experience and strong theoretical background in combining lipid components to obtain liposome formulations with desired features.

Purification Techniques
Deep knowledge of gel filtration methods through column separation. During the master's thesis project sephadex columns were used to remove free hydrophilic drugs and dyes from the solution bulk of liposome samples through centrifugation.
Good practice in dialysis methods to remove free calcein from liposomes samples.
Outstanding experience in particle purification through free sample centrifugation. This method was widely employed by the candidate to separate printed PEG micro hydrogels from free unpolymerized PEG residuals at Istituto Italiano di Tecnologia.

Microfluidics
Thanks to the research carried out at IIT the candidate developed remarkable competence in the design and fabrication of microfluidic devices. Polydimethylsiloxane (PDMS) microfluidic chips were sealed on the glass surface thanks to the Oxygen Plasma Treatment method performed by the Plasma System available in the IIT clean room facility. The chips were daily employed to provide the microfluidic flux required in the TP-Continuous Flow Lithography process.

Lithographic Techniques
Strong theoretical background in lithographic techniques for fabrication of microparticles.
Extremely competent in Two Photon-Continuous Flow Lithography technique thanks to the experience gained at IIT.

Microscopy Techniques
Excellent expertise in optical and fluorescence microscopy employed at IIT for the characterization of micro hydrogels.
Sample preparation for Scanning Electron Microscopy and Transmission Electron Microscopy, SEM and TEM data analysis for the characterization of micro hydrogels.
Atomic Force Microscopy practice and data analysis applied to the study of biomechanical response of bowel cancer cells at Università Cattolica del Sacro Cuore.

Chromatographic Techniques
High-performance Liquid Chromatography data analysis for the quantification of lipid content in liposome samples.

IT SKILLS

Operative systems: Linux (Intermediate), Windows (advanced), Ubuntu (Intermediate)

Basic skills: electronic sheets (advanced), internet searching (advanced), multimedia (intermediate), data analysis programs (advanced), bibliographical research (advanced)

Softwares: Office programs, internet Explorer, Google Chrome, Mozilla Firefox, La TeX editors (TeXstudio, Lyx), Origin 8.1, C/C++ editors (Dev-C++), Python development environments (Spyder), MiePlot, Malvern Zetasizer Software, ImageJ, Olympus Flowview, Leica Application Suite X (LAS X), labVIEW environment, Laser Transmission Spectroscopy Software

Programming Languages: C, Python, notions of Fortran

Main Implemented Programs
-"Asymptotic behaviour of Conway's Game of Life", Physics of Complex Systems course deepening, written in Python
-Molecular systems simulations for the course of Computational Statistical Mechanics, written in C
- Program for the derivation of the concentration in a solution of liposomes from the pseudo-scattering UV-Vis signal of the vesicles, written in C

LANGUAGE SKILLS

Italian: mother tongue
English: B2 level,
Cambridge English First (FCE2 o B2 First)
Date: June 2011
Reference Number: 116IT2400090

SCIENTIFIC ACTIVITY

Since the earlier experiences the candidate's research activity is focused on the **design, fabrication and characterization of nanoparticles for pharmacological applications and diagnostics.** The candidate's research experience includes the study of liposomes, liposome aggregates, niosomes, exosomes and nanoparticle loaded micro hydrogels.

The candidate's first experience in the field of the nanoparticles concerned the study of re-entrant condensation on polylysine-decorated, negatively charged liposomes in the perspective of designing new vectors for a multi-drug approach for the treatment of tuberculosis. The controlled aggregation of the vesicles was verified successfully, but the first attempts to encapsulate hydrophilic drug isoniazid showed a low encapsulation efficiency of the molecule by the vesicles. Further investigation of this phenomenon was the core of the candidate's master's thesis internship.

The aim of the work was to ascribe the low encapsulation level to a membrane leakage of the liposomes or to a loss of vesicles due to preparation procedures. To that purpose, was validated for the first time on liposomes the innovative Laser Transmission Spectroscopy (LTS) technique.

This technology simultaneously allows for an accurate estimation of the actual radius and the absolute number concentration of particles in a suspension, thus ensuring a more precise evaluation of the actual encapsulation efficiency of vesicles.

Subsequently the candidate started an internship at UCSC Università Cattolica del Sacro Cuore joining a project focused on the characterization through Dynamic Light Scattering and Laser Doppler Electrophoresis of the size distribution and colloidal stability of exosomes. The study also included biomechanical response of bowel cancer cells at different stages of the epithelial-to-mesenchymal transition through Atomic Force Microscopy measurements.

Later the candidate's joined as visiting scientist the *Nanotechnology for Precision Medicine* group at IIT Istituto Italiano di Tecnologia in Genova. Here as part of the MINDED project the research was focused on innovative Two Photon-Continuous Flow Lithography methods for the fabrication of nanoparticle loaded micro hydrogels to be employed for drug delivery purposes.

PUBLICATIONS

Purnima N. Manghnani, Valentina Di Francesco, Carlo Panella La Capria, Michele Schlich, Marco Elvino Miali, Thomas Lee Moore, Alessandro Zunino, Marti Duocastella, Paolo Decuzzi
"***Preparation of anisotropic multiscale micro hydrogels via two-photon continuous flow lithography***"
Journal of Colloid and Interface Science 608 (2022) 622–633
https://doi.org/10.1016/j.jcis.2021.09.094

ATTENDANCE OF SEMINARS

-"Big Data, Neural Network e Machine Learning", S. Giagu, G. Salina, F. Pirri; 29/11/2018

-"Esperimento SOX, Rapporto tra Scienza e Cittadinanza", Giorgio Parisi, A. Capocci, C. Cosmelli; 13/12/2017

-" Genetic networks and the flow of positional information in embryonic development", William Bialek; 06/06/2016