DOCTORAL THESIS IN ATOMIC AND MOLECULAR PHOTONICS

Light responsive materials for tethered robotic function

PhD open position within the doctoral network "Soft Active Matter Microrobots for Medicine (SAM3)", funded by EU HORIZON-MSCA-2025-DN-01-01 # 101312674

Collaboration Prof. Camilla PARMEGGIANI (LENS, Firenze, Italy), Dr Anne DELETTRE (Percipio, Besançon, France), Prof Pierre LAMBERT (ULB, Bruxelles, Belgium)

Research project on Light responsive materials for tethered robotic function (SAM3/ESR2 – light)

This project takes place within the Marie Curie Doctoral Network on Soft Active Matter Microrobots for Medicine (SAM3). This doctoral network of 12 PhD candidates aims at exploring the ear-nose-throat area from a microrobotics perspective. Thanks to active matter and small scale microrobotics engineering, three specific goals are targeted: (1) access the middle ear through the Eustachian tube; (2) access the olfactory clefts for mucosal biopsy; (3) access the skull cavity through the nose and the cribble plate for cerebrospinal fluid biopsy.

This specific PhD proposal on light responsive materials for tethered robotic function is part of the second endoscopic area namely the olfactory clefts. The goal of the PhD is to develop 3D-printable light responsive materials based on Liquid Crystalline Networks (LCNs) suitable for tethered robotic function. Combining selective functionalization with photo-switches and structuring with photolithographic techniques, the LCNs will be exploited to demonstrate different actuation functions (including grasping, taking or releasing micro-objects or liquids) at the microscale.

The expected results are further set as follows: 1) **Synthesis of polymerizable azobenzene dyes** that exhibit quantitative and stable cis-isomer formation under visible or near-infrared (NIR) light; 2) **Overcoming limitations of standard LCN microstructures** to achieve deformability in biological environments by using bistable materials and enabling purely optical deformation through isomerization processes; 3) **Fabrication of 3D microstructures** (ranging from tens to hundreds of micrometers) via photolithographic techniques and characterization of their deformation under external light stimuli 4) **Development of sponge-like microstructures using porous LCNs,** followed by testing their ability to release liquids upon light irradiation and to adsorb liquids through light-induced processes (using standard dye solutions) 5) **Integration of 3D-printed microgrippers or porous structures** onto optical fibers and demonstration of actuation via in-situ irradiation, including tests in opaque environments (where external illumination is not feasible) and within anatomical phantoms.

The candidate will be enrolled as PhD student at UNIFI (Firenze, Italy), in the International Doctorate of Atomic and Molecular Photonics. A co-supervision is planned with Dr Sara NOCENTINI at LENS.

An industrial stay of 6 months is planned at Percipio robotics (Dr Anne DELETTRE, Besançon, France) for the integration of printed structures over other elements used in microsurgery and an academic stay of 4 months is planned at ULB (Prof Pierre LAMBERT, Bruxelles, Belgium) for the design of 3D microactuators, testing inside phantoms.

Research environment

The main research lab will be the Laboratorio Europeo Di Spettroscopie Non Lineari (lens.unifi.it), in the Scientific Campus of the University of Florence (LENS, Sesto Fiorentino Campus, Firenze, Italy).

The PhD student will be supervised by Prof. Camilla PARMEGGIANI (LENS, Firenze, Italy) and co-supervised by Dr Sara NOCENTINI (LENS, Firenze, Italy).

Both supervisors of this project have complementary expertise towards the goals of this PhD: photo-switch synthesis, polymer design and synthesis, microfabrication and light actuation testing.

More information on the supervisors:

- Prof. Camilla PARMEGGIANI, professor of industrial chemistry at the Department of Chemistry "Ugo Schiff" of UNIFI and associate researcher of LENS leading research in the fields of smart materials for soft robotics and biological application. Recently she has coordinated different projects related to the development of light responsive artificial muscle based on liquid crystal (e.g. FET-PROACTIVE – REPAIR)
- Dr Sara NOCENTINI, PhD, senior researcher of the Istituto Nazionale di Ricerca Metrologica (INRiM) and associate of LENS. Expert in microfabrication of responsive polymers, she is leading the project ERC-StG 3DNanoGiant related to 3D printed liquid crystal materials for non-linear optics.

LENS and University of Florence are equipped with all necessary facilities for polymer synthesis, manufacturing and characterization at the small scale.

For the implementation of the project, the candidate would move for 6 months to Percipio Robotics (France) and 4 months to ULB (Belgium).

Job description and profile for SAM3/ESR2

We will appoint 1 PhD student on this project, related to 11 other positions open in the SAM3 EU network.

He/she will be registered within International Doctoral School coordinated by Laboratorio Europeo Di Spettroscopie Non Lineari at UNIFI with Prof. C. PARMEGGIANI as supervisor.

The candidate should have a master degree or diploma in chemistry, material science, material engineering, or related topics, less than 5 years of career at the recruitment date and not having a doctoral degree.

We are seeking talented and enthusiastic students to perform a PhD, with a solid background in polymer chemistry and technology or 3D printing of smart materials. Regarding skills, we look at ability for research management, dissemination, communication with colleagues and supervisors, strong teamwork spirit, creativity, problem solving and attention to safety.

The candidate should have good command of spoken and written English, and Italian or French skills are of course an asset.

For more information regarding the PhD studies at the UNIFI please check the website (https://lens.unifi.it/phdschool/).

How to apply

Applications should be sent to the mailbox SAM3@umons.ac.be dedicated only to recruitment. They should include: a) a digital copy with all academic certificates and the respective official transcription in English; b) a detailed CV and a motivation letter in English; c) 2 letters of recommendation.

Duration: 3 years full time.
Starting date: Autumn 2026
Deadline for the submission of applications: 15/7/2026 though the position will remain open until it is filled.