DOCTORAL PROGRAMME
IN
CHEMICAL SCIENCES

Director prof. Anna Maria Papini

XLII cycle – academic year 2026/2027

SCIENTIFIC AREA	
ADMINISTRATIVE OFFICE	Department of Chemistry "Ugo Schiff" (DICUS)
WEB	www.dottoratoscienzechimiche.unifi.it
CURRICULA	**1.** Chemistry **2.** Science for the Conservation of Cultural Heritage
	POSITIONS AVAILABLE: 17 Positions with Scholarship: 17 Positions without Scholarship: *not available*
RANKING LIST FOR STANDARD POSITIONS SCHOLARSHIPS AVAILABLE: 3	**1** - University of Florence **2** - Department of Chemistry "Ugo Schiff" (DICUS) Progetto Ministeriale "Dipartimento di eccellenza 2023-2027" 58503_DIPECC_23_27 CUP B97G22000740001
RANKING LISTS FOR POSITIONS WITH SPECIFIC RESEARCH TOPICS SCHOLARSHIPS AVAILABLE: 12	**2** - Department of Chemistry "Ugo Schiff" DICUS **Thematic 1:** "Development of new libraries of surfactants from sustainable sources to tailor their self-assembly properties" **Project description:** The PhD fellowship is fully funded by the Italian Science Fund (FIS Call 3) through the Starting Grant "BioSurfRel". The development of new formulations based on non-ionic surfactants is a crucial issue in numerous technological sectors, aimed at replacing nanostructured fluids that are non-degradable and/or derived from fossil resources. To this end, the proposed PhD project will focus on the synthesis of new libraries of surfactants from renewable sources by varying molecular architecture, chain length, and chemical composition. The synthetic work will be accompanied by the formulation of new nanostructured systems and their characterization, with a view to applications in detergency and cultural heritage preservation. The student will be responsible of: (i) developing methodologies for the synthesis of such amphiphilic molecules, with a particular focus on functionalization processes using controlled synthesis techniques; (ii) studying the dynamics of the produced surfactants in dilute solutions and their properties in bulk. Finally, (iii) the candidate will develop a research rationale to correlate the structure of the surfactants obtained with their properties. The proposed research activity adopts an interdisciplinary approach in which synthesis and physico-chemical characterization will represent the core of the work carried out. Funded by FIS3_2024_BANDELLI CUP B53C25003780001

Thematic 2: "Design of nanostructured fluids to develop structure–property relationships"

Project description: The PhD fellowship is fully funded by the Italian Science Fund (FIS Call 3) through the Starting Grant "BioSurfRel". The development of "green" formulations capable of replacing products derived from fossil resources is an open challenge that requires a clear and robust formulation rationale. To this end, the PhD project associated with this position will deal with the development of new nanostructured fluids obtained both from commercial surfactants and from analogous surfactants produced within the funding project. The candidate will: (i) approach and deepen formulation processes for the preparation of self-assembly systems; (ii) will develop and adapt methodologies to analyze the obtained products, with a particular focus on their scattering and rheological properties. Particular attention will then be given to (iii) the analysis of structure–property relationships of the systems obtained, with possible applications in fields such as Cultural Heritage preservation. These objectives will be pursued through the sequential development of knowledge acquired during the project. For this purpose, the PhD work will be supported by continuous exchange with the project members, with the ultimate goal of enabling the translation of experimental data into input for the development of new surfactants and nanostructured systems.

Funded by FIS3_2024_BANDELLI CUP B53C25003780001

8 - Cofunded by University of Florence and Department of Chemistry "Ugo Schiff" DICUS

Thematic 1: "Development of Generative Deep Learning Architectures for the Design of Periodic Systems Based on Open-Shell Nanographenes"

Project description: Carbon-based magnetic systems present an electronic and magnetic structure of extreme interest for spintronics and quantum computing. However, the computational design of 1D and 2D nanographene systems is hindered by prohibitive calculation times, making chemical space exploration inefficient. To overcome this limitation, the project will develop generative Deep Learning architectures (e.g., GNNs, Diffusion Models) for inverse design. AI models will generate in silico novel periodic networks optimizing specific quantum targets: magnetic couplings (ferro/antiferro), spin frustration, spin-electric coupling, and coupling with excited states. This approach will bypass the limits of standard methods, accelerating the discovery of advanced quantum materials.

Cofunded by FIS2_2023_BRIGANTI CUP B53C24009560001

Thematic 2: "Advanced Methods in the Electroplating of Metals and Metal Alloys"

Project description: The latest publications on the European Community's list of "Critical Raw Materials" (CRM) have highlighted that not only platinum group metals (PGMs), but also many others such as copper and nickel, are included in the CRM list as strategic raw materials in the technological, industrial, and energy sectors. Therefore, their recovery and sustainable use are crucial, seeking the most homogeneous, efficient, and corrosion-resistant electrodeposition. Achieving this requires a multidisciplinary study that includes a multiphysics theoretical study of complex systems, the use of pulsed currents, and minimal metal waste with high-yield, low-cost systems.

Cofunded by INNOCENTIAMPERE CUP D14E20006370009, INNOCENTI_LUXOTTICA_2023, INNOCENTI-VALMET-2023

Thematic 3: "Development of synthetic receptors for the biomimetic recognition of biologically relevant carbohydrates"

Project description: Carbohydrates are widely displayed on eukaryotic cell surfaces as

	glycoconjugates with lipids and proteins and play essential roles in physiological and pathological processes. Biomimetic synthetic receptors capable of non covalent carbohydrate recognition provide valuable tools to elucidate these mechanisms. This project aims to develop new synthetic receptors with improved affinity and tunable selectivity for biologically relevant mono and oligosaccharides. Different receptor architectures will be explored, along with the synthesis of carbohydrate guests. Binding properties will be investigated using spectroscopic and calorimetric techniques, including NMR, circular dichroism and ITC. Cofunded by OSCARFRANCESCONIPRIN2017 CUP B94I18007180001, OSCARFRANCESCONIPRIN2020 CUP B97G21000060001, PRIN2022_FRANCESCONI CUP B53D23015570001 **Thematic 4:** "Early detection of degradation in organic materials of polychrome artworks using fluorescence lifetime" **Project description**: This project investigates early signals of chromatic alteration due to photo-ageing in organic materials of polychrome artworks through fluorescence lifetime analysis. It aims to explore how lifetime properties evolve during initial ageing stages, even before visible colour changes occur. The study will focus on model systems representative of historical painting materials, including binders and dye–binder mixtures, subjected to controlled ageing. Using a phasor-based approach, lifetime variations will be analysed to identify reproducible patterns associated with early material transformations. The project will assess the potential of fluorescence lifetime as a non-invasive indicator for the early detection of incipient degradation in cultural heritage materials. Cofunded by ERC_SHADES_DiTuro CUP B97G25000550006 **Thematic 5:** "Study of the interaction of bioactive molecules with natural polymer matrices for drug delivery applications" **Project description**: The project aims to investigate the mechanisms of adsorption and release of bioactive molecules within scaffolds based on naturally occurring polymers. The objective of the research is to analyse the interactions between the polymeric matrix and the active ingredient, with a view to optimising them to achieve highly efficient delivery systems. The investigation of these interaction processes will be conducted using various spectroscopic techniques, including the use of specifically designed chromophores. In parallel, surface modification of the matrix is planned to increase its affinity for specific therapeutic targets. The use of biocompatible natural polymers will enable the development of advanced drug delivery systems. Cofunded by MISE_GRAFENEX_CICCHI CUP B99J23000260005 **Thematic 6:** "GREEN monitoring of environmental contaminants via advanced sensing" **Project description**: This PhD project aims to develop next-generation electrochemical sensors based on sustainable and innovative materials for the detection of emerging contaminants, with a focus on per- and polyfluoroalkyl substances (PFAS). The research will exploit 2D and 3D printing technologies using functional inks formulated with eco-friendly materials and deposited onto sustainable substrates. This approach will enable the fabrication of robust, scalable, and low-impact sensing devices. Integration within (micro)fluidic systems will allow real-time, on-site monitoring in complex environmental matrices. The project combines advanced materials design, additive manufacturing, and electrochemical sensing to deliver sustainable analytical solutions for environmental monitoring. Cofunded by PALCHETTI_BIOSENSOR, 20128ZZS2H CUP B18C13001590001 **Thematic 7:** " Spin-electric effects in molecular materials for quantum technologies" **Project description**: The PhD candidate's research activity will focus on one or both of

	the following aspects: 1. Design, synthesis, and characterization of multispin molecular systems with optimized response to electric fields (e.g., mixed-valence systems, photoinduced electron transfer systems, spin-frustrated systems); 2. Magnetic and spectroscopic characterization of multispin systems, and development of experiments aimed at the quantification and rationalization of spin–electric coupling. Cofunded by ELECOS_FIS21_Sessoli CUP B53C23007640001 **Thematic 8:** "Synthesis of estrogen receptors ligands as probes of neuroendocrine function in the brain" **Project description**: Estrogens play a complex role in several cognitive functions, and their receptors (ER) are distributed in cells throughout the brain. Studies on gender differences in Alzheimer's disease (AD) suggested a role of ER subtypes in AD progression, although their exact functions and mechanisms in the brain and during diverse stages of neurodegenerative diseases is still to be understood. Thus, starting from the study of ERα and ERβ structural data, the aim of this project is to synthesize and study highly specific ligands for the different brain ER subtypes as imaging agents to map ERs in brain tissue and decipher estrogen signaling in the occurrence and progression of AD. Cofunded by TRABOCCHI_WELLCOMELEAP_CARE_DEEPER CUP B97G25000390007 **1** - Cofunded by University of Florence, Department of Chemistry "Ugo Schiff" DICUS and Department of Industrial Engineering DIEF **Thematic:** "Helical shaped chiral systems: Synthesis, characterization and applications" **Project description**: This project focuses on the development of novel functional heterohelicenes through enantioselective synthetic strategies and their comprehensive structural, redox and chiroptical characterization. Particular attention will be devoted to their photoinduced properties, including charge and energy transfer processes and radical formation. Owing to the combination of chirality, extended π-conjugation and redox activity, these systems will be explored as multifunctional platforms for advanced materials and phototherapy applications, especially for the generation of reactive oxygen species (ROS) in photodynamic processes. The project integrates organic synthesis, spectroscopy and electrochemistry to establish structure–property relationships. Cofunded by SESSOLI_ERC-2022-SYG_CASTLE CUP B97G21000120006 at Department DICUS and FIS-2023-01975 CUP B53C24009570001 at Department DIEF **1** - Cofunded by University of Florence and CNR-ICCOM Istituto di Chimica dei Composti Organometallici **Thematic:** "Nanostructured materials for Green Energy electrochemical technologies: Carbon Capture, e-Fuels, and Hydrogen" **Project description**: The research project focuses on the design, synthesis, and characterization of nanostructured catalytic materials for electrochemical devices, such as fuel cells, electrolyzers, and electrochemical carbon capture systems. Catalysts for fuel cells will be developed to utilize e-fuels (hydrogen, alcohols, and formic acid) for power generation, alongside catalysts for hydrogen production in electrolyzers. The research will also cover the development of Electrochemically Mediated Amine Regeneration (EMAR) technology for carbon capture and utilization. The study of the relationship between nanostructure and catalytic activity will be supported by the application of computational chemistry methods.
RANKING LISTS FOR	**Agenzia Spaziale Italiana – ASI** **Call for funding of 45 scholarships on topics of interest to ASI**

POSITIONS WITH SPECIFIC RESEARCH TOPICS SCHOLARSHIPS AVAILABLE: 2 *(subject to the grant of funding)*	**Thematic 1:** "Development of liquid crystal–based smart polymers for radiation shielding in aerospace applications" **Thematic 2:** "Molecularly Imprinted Polymers for New Explorations: Synthetic Antibodies for On-Demand Diagnostics in Long-Duration Space Missions" **Please note: scholarships will be awarded ONLY if the respective funding will be granted**
STUDY/RESEARCH PERIODS ABROAD	at least 6 months
DOCUMENTS REQUIRED FOR THE ADMISSION	• Copy of the Identification Document • **Self-certification** for qualifications obtained in Italy (laurea triennale, specialistica o magistrale o ciclo unico) with list of exams taken, credits and related grade, title of the thesis and graduation mark (using this **template** or similar forms containing the required information) • Qualifications obtained abroad (Bachelor's and Master's Degrees or combined cycle Degree) with a list of all exams taken, credits and related grade, rating scale, title of the thesis and graduation mark *The same documentation except for the final mark must be submitted by those who will graduate within the 31/10/2026*
DOCUMENTS REQUIRED FOR THE EVALUATION	**MANDATORY** • Curriculum vitae et studiorum including a typewritten self-declaration for each qualification obtained (bachelor and master, or combined cycle degree) reporting the date of first enrollment, exams passed with number of credits, weighted and arithmetic average of the marks • One Research project for EACH fellowship the candidate shall compete (each one shall be congruent to each specific thematic (up to 13 projects) • Title and extended abstract of the M.Sc. thesis (maximum five A4 sheets) **OPTIONAL** • List of scientific publications • List of qualification documents including periods spent abroad for study or research mobilities • Up to a maximum of two reference letters
RESEARCH PROJECTS	Each research project shall be written in English in no more than 5,000 characters including spaces, use a 12-point font and single-spaced lines, abstract (no more than 500 characters including spaces), references (maximum 5), in order to assess the applicant's aptitude to research. The candidate can apply for several rankings by submitting a specific research project for each ranking (clearly state the reference to the specific topic).
INTERVIEW MODE	**In person**

<table>
<tr><td></td><td>In the application form candidates may ask to conduct the interview remotely</td></tr>
<tr><td>FURTHER INFORMATION</td><td>The interview can be conducted in the English language.
If it is presented in Italian, the interview shall include an assessment of English language proficiency.</td></tr>
<tr><td>EVALUATION MARKS</td><td>
<table>
<tr><th>parameter</th><th>minimum score</th><th>maximum score</th></tr>
<tr><td>Curriculum vitae et studiorum, research project, publications, other qualification documents</td><td>40/120</td><td>60/120</td></tr>
<tr><td colspan="3">Applicants who obtain a mark of at least 40/120 in the evaluation of the above parameters will be admitted to the interview</td></tr>
<tr><td>Interview: discussion of the research project, publications and qualification documents</td><td>40/120</td><td>60/120</td></tr>
<tr><td colspan="3">Eligibility is achieved with a minimum score of 80/120</td></tr>
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</td></tr>
<tr><td>FURTHER INFORMATION ON THE EXAMINATION</td><td>The interview will be focused on each research project. The discussion with the committee members will be based on the scientific background of the candidate also in the field of the research performed for the Bachelor and Master thesis or for equivalent titles. Each research project must be presented by maximum 8 slides. Moreover, the candidate can present 1 slide to introduce the CV.</td></tr>
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EXAMINATION SCHEDULE			
	DATE	**TIME**	**PLACE**
INTERVIEW	July 16-17th 2026	08:30 a.m.	Biblioteca “Parrini” Via della Lastruccia, 13 Sesto Fiorentino (Florence)
The list of the candidates admitted to the interview and the final ranking will be published at the page **PhD courses**			

ENROLLMENT ROUNDS
Enrollment must be completed within the specified mandatory deadlines, under penalty of exclusion (as per Art. 12 of the Call for Applications - Annex 1)

	Opening Date	Deadline for Enrollment
Enrollment (successful candidates)	Ranking's publication date (by July 31, 2026)	by **11.59 pm** (CEST) on **August 25th 2026***
1st round (eligible candidates)	from **31st August 2026**	by **11.59 pm** (CEST) on **September 7th 2026**
2nd round (eligible candidates)	from **10th September 2026**	by **11.59 pm** (CEST) on **September 17th 2026**

** Please note that the University will be closed from August 8th to August 23th, 2026.*

Subsequent reassignment of vacant positions:

The reassignment of any residual positions after the first two rounds will be activated on **every Tuesday until October 27th**, with a mandatory enrollment deadline set for the following Friday (11:59 PM CEST). It is the sole responsibility of the candidate to check their personal reserved area

No personal communications will be sent to candidates.

Technical instructions for enrollment can be found **here**