NANOCHEMISTRY CAMP 2025

26 September – 3 October (Iseo, Camping del Sole, Italy)

NANOCHEMISTRY

Nanochemistry deals with the fundamental aspects of nanotechnology, straddling the boundaries of physics, chemistry, and biology. Nanotechnology is the science and technology of objects that have an intermediate size between larger molecules and the smallest structures we are currently able to manufacture; it is the science of objects with dimensions ranging from a few nanometers to hundreds of nanometers (1 nm is one billionth of a meter).

Nanochemistry has profound implications, encompassing both technological advancements and sustainable development. For instance, it has diverse effects on society, particularly in the electronics and energy sectors, resulting in the creation of compact, efficient devices and the advancement of battery technologies. Moreover, it has revolutionized medicine by facilitating targeted drug delivery and early disease detection through highly sensitive sensors. Additionally, nanochemistry significantly contributes to environmental sustainability by aiding in the removal of pollutants from water and air purification, as well as reducing resource consumption and environmental impact in material production.

THE CAMP

The Nanochemistry Camp is an international residential summer school aimed at master's and doctoral students in chemistry and allied fields, where nanochemistry plays a key role. It delivers top-tier, cutting-edge insights on pivotal topics in nanochemistry, by featuring an original and innovative format that brings together students and globally renowned experts in (nano)chemistry, including Nobel laureates, in a comfortable and informal environment at one of the most beautiful campsites overlooking Lake Iseo (https://www.campingdelsole.it/en/).

The educational program includes 3-hour classes with each professor, consisting of about 1.5 hours of lecture followed by an equal amount of time for discussion. Additionally, the program incorporates community-building activities where students have the opportunity to engage with professors and each other regarding their research activities and future projects. To promote this interaction, poster pitch presentations, team-building activities, trekking, and responsible tourism outings are scheduled.

Master's and doctoral students, and young post-doctoral researchers are eligible to apply for the Camp. Admission is subject to selection by the Scientific Committee, based on the abstract of the scientific contribution, motivation letter, and CV.

THE SPEAKERS

- DEBORA BERTI, University of Florence
- CARLA BITTENCOURT, University of Mons
- ALAIN CELZARD, University of Lorraine
- ELISABETTA COLLINI, University of Padua
- STEVEN DE FEYTER, KU Leuven University
- MORTEN MELDAL, Nobel Laureate in Chemistry 2022
- EMILIO M. PÉREZ, IMDEA Nanociencia

AGENDA

FRIDAY 26th SEPTEMBER

Daytime	Participants' arrival to Iseo
7.00 p.m. – 7.45 p.m.	Course and participants' introduction
8.00 p.m.	Welcome dinner at the Camping's restaurant

SATURDAY 27th SEPTEMBER

9.00 a.m. - 12.00 p.m. Lecture **Morten MELDAL** | Nobel Laureate in Chemistry, 2022

Title: "*Clicking and Technology in Chemical Biology*"

Abstract: Click chemistry application to derivatise surfaces and nanostructures and to stable de-novo protein structures will be presented. Resulting structures are used in chemical biology to study molecular recognition, molecular processing and signaling. The custom platform technology of Center of Evolutionary Chemical Biology will be discussed including optical encoding technology and preparation of biocompatible resins for synthesis and aqueous screening techniques.

1.00 p.m. Lunch at the Camping's restaurant

2.30 p.m. – 5.30 p.m. Lecture **Alain CELZARD** | University of Lorraine

Title: "*Nanochemistry and Porous Materials – From Fundamentals to Applications*"

Abstract: Nanochemistry explores matter at the nanoscale, where size-dependent properties like surface area, reactivity, and quantum effects emerge. When combined with porous materials—structures containing well-defined internal voids—these effects enable precise control over molecular transport, catalysis, and adsorption.
Porous materials—such as zeolites, metal-organic frameworks (MOFs), mesoporous silica, and porous carbons—are characterized by their internal voids, which can be classified as microporous, mesoporous, or macroporous depending on size. These pores influence mass transport, adsorption, and reaction kinetics, making such materials highly effective in applications like catalysis, gas separation, energy storage, and biomedical delivery systems. The synthesis of porous nanomaterials can involve bottom-up approaches like self-assembly or sol-gel processes, as well as top-down methods such as etching or exfoliation. Control over structure at the nanoscale is often achieved using templating agents or surfactants. Advanced characterization techniques—including BET surface area analysis, electron microscopy, and spectroscopy—are essential to understand and optimize their performance.

Porous architectures are also found in nature, inspiring bioinspired materials for structural, energy, or medical uses. Beyond their practical applications, nanostructured porous materials raise important considerations related to safety, sustainability, and scalability in industrial and environmental contexts.

7.30 p.m. Dinner in the typical Italian restaurant "Osteria ai Cancelli" in Iseo

SUNDAY 28th SEPTEMBER

9.45 a.m. – 6.00 p.m. Visit to the picturesque island Monte Isola and hike to Santuario Madonna della Ceriola, with its breathtaking view on Lake Iseo

7.30 p.m. Dinner at the Camping's restaurant

MONDAY 29th SEPTEMBER

9.30 a.m. - 11.30 a.m. Lecture **Debora BERTI** | University of Florence

Title: "*Colloid and Interface Science meets Biological Function*"

Abstract: Self-Assembly and compartmentalization are defining features of biological systems. At the same time synthetic soft matter materials exhibit similar behavior, with structural and dynamical properties of the same length and time scales. Hence, soft matter can serve as a biomimetic platform, not only to explore complex processes at living interfaces, but also to inspire the design of new hybrid materials that can be used effectively in biological environments. In this lecture, I will illustrate, through a series of case studies, how these design principles can be explored and translated to investigate the nano–bio interface and to engineer functional hybrid colloidal systems. Over the past few years, we have advanced the understanding of how lipid membranes guide the assembly of gold nanoparticles (AuNPs), using both synthetic bilayers and biologically derived extracellular vesicles (EVs). Our findings reveal that membrane composition, mechanics, and nanoscale organization critically dictate nanoparticle behavior—from structural arrangement and optical response to biological interaction and colloidal stability. These insights provide a rational framework for the design of lipid–AuNP hybrid systems with controllable plasmonic properties, targeted delivery capabilities, and enhanced sensing performance.

11.30 a.m. – 12.30 p.m. Seminar **Debora BERTI** | University of Florence

Title: "*Write. Submit. Survive: A Journey through Scholarly Publishing*"

1.00 p.m. Lunch at the Camping's restaurant

2.30 p.m. – 6.30 p.m. Lake view poster presentation and discussion

7.30 p.m. Dinner at the Camping's restaurant

TUESDAY 30th SEPTEMBER

9.30 a.m. - 12.30 p.m.

Lecture **Steven DE FEYTER** | KU Leuven University

Title: "*Nano(bio)chemistry on surfaces – seeing is believing*"

Abstract: Surfaces play a central role in nanoscience, as the surface-area-to-volume ratio increases dramatically at the nanoscale, making surface phenomena dominant in dictating material properties. Catalysis, adsorption, charge transfer, and other critical interactions typically occur at or near surfaces, rendering their atomic structure and chemical composition key parameters in the rational design of nanoscale materials and devices.
Molecular functionalization of surfaces is a cornerstone of modern nanoscience. It allows precise tuning of interfacial properties to achieve specific chemical, physical, or biological functionalities. Surfaces can also act as scaffolds or templates for the bottom-up growth of novel ultrathin materials, including 2D molecular networks, 2D polymers, and hybrid nanostructures. High-resolution surface characterization at the (sub)molecular scale is essential for understanding and controlling these complex interfacial processes. Techniques such as scanning tunneling microscopy (STM) and atomic force microscopy (AFM) provide real-space access to individual molecules, offering deep insight into molecular organization, defects, reactivity, and dynamic behavior. In this lecture, we delve into the field of molecule-based surface nanoscience. We will examine strategies for functionalizing surfaces with spatial precision—often via nanopatterning or self-assembly—and explore the emergent properties enabled by such precise control. Emphasis will be placed on local probe techniques, which not only visualize but also manipulate matter at the molecular scale, offering an unparalleled window into the molecular world on surfaces.

1.00 p.m. Lunch at the Camping's restaurant

3.30 p.m. – 5.30 p.m. Visit to Brescia city centre

5.30 p.m. – 7.30 p.m. Free time in Brescia

7.30 p.m. Dinner in pizzeria "Pizzium" in Brescia

WEDNESDAY 1st OCTOBER

9.30 a.m. - 12.30 p.m.

Lecture **Emilio M. PÉREZ** | IMDEA Nanociencia

Title: "*Chemical tools for SWNTs and 2D materials*"

Abstract: Nanomaterials owe their extraordinary properties to a combination of quantum confinement in their electronic structure and extreme increase in the surface to volume ratio compared to most bulk materials. Chemistry is a very valuable tool to fully profit from all the potential of nanomaterials, as it can serve to tune their intrinsic electronic properties and add further functionalities while providing control over the interface between nanomaterials and their surroundings.

Our research group is interested in three main lines: 1) the modification of single-walled carbon nanotubes through mechanical bonding, 2) the covalent chemistry of 2D materials, and 3) supramolecular chemistry at the level of single molecules. In this lecture, we will focus on the chemistry of SWNTs and 2D materials.
We will first discuss the characteristics of the mechanical bond that make it appealing for SWNTs. We will then describe the potential advantages of making mechanically-interlocked derivatives of SWNTs (MINTs), as compared to covalent or classic supramolecular derivatives of SWNTs, and go on to explain our approach for the synthesis of MINTs. Finally, we will illustrate with examples how the making of MINTs can contribute to modifying the surface properties of SWNTs, modulating their electronic properties, and linking them to functional molecular fragments.
Secondly, we will discuss the inherent challenges in the covalent chemistry of 2D materials and present some of the approaches we have developed towards their functionalization. We will also discuss how these chemical tools can be used to interface 2D materials, venturing into 2D-2D heterostructures that extend beyond conventional van der Waals interactions.

1.00 p.m. Lunch at the Camping's restaurant

2.30 p.m. – 5.30 p.m. Lecture **Carla BITTENCOURT** | University of Mons

Title: "*Exploring Gas-Surface Interactions: From Fundamentals to Applications of Near-Atmospheric Pressure X-Ray Photoelectron Spectroscopy in Catalysis, Sensing, and Environmental Studies*"

Abstract: Gas-surface interactions play a crucial role in various applications, particularly in the development of gas sensor technologies. Within this domain, near-atmospheric pressure X-ray Photoelectron Spectroscopy (NAP-XPS) emerges as a significant analytical technique, enabling detailed investigations of gas-surface interactions. NAP-XPS facilitates the real-time monitoring of surface chemistry alterations in materials exposed to diverse gaseous environments and external parameters, including temperature and pressure fluctuations. This capability is instrumental in elucidating the kinetics and thermodynamics of gas-surface reactions, thereby providing essential insights for the design and optimization of catalytic materials and functional surfaces. For example, in catalytic reactions on metal surfaces, NAP-XPS can monitor the oxidation states of metals such as Pt or Pd, providing insights into the catalytic mechanisms under varying reactant pressures. In gas sensor applications, NAP-XPS can analyse how target gas molecules adsorb onto sensor materials, resulting in changes to their electronic structure that enhance sensitivity and selectivity. Additionally, NAP-XPS has been applied to study polymer films, showing how gas exposure modifies their surface chemistry, and in battery materials, where it observes electrochemical processes during cycling. We will discuss the basics of XPS analysis, from the fundamentals to the latest developments in novel NAP-XPS spectrometers, highlighting its versatility and importance in advancing research across multiple fields.

7.30 p.m. Dinner at the Camping's restaurant

THURSDAY 2nd OCTOBER

9.00 a.m. - 12.00 p.m. — Lecture **Elisabetta COLLINI** | University of Padua

Title: *"2D Electronic Spectroscopy: Principles, Applications, and Emerging Opportunities in Nanosystems and Quantum Technologies"*

Abstract: Two-dimensional electronic spectroscopy (2DES) has gained significant attention for its unique ability to track ultrafast coherent and incoherent processes in real time.
While the technique has traditionally been associated with studies of energy and charge transport in molecular materials, its potential is increasingly being recognized in the context of nanomaterials and nanodevices. In particular, 2DES offers a powerful means of probing coherent mechanisms involved in excitation energy transport, with implications for emerging quantum technologies. With the convergence of advanced experimental capabilities and promising application domains, the potential of 2DES to impact fields such as nanoscale systems, quantum devices, and quantum information science is becoming increasingly evident. This lecture introduces the fundamental physical principles of 2DES and demonstrates how it can be employed to investigate dynamic photophysical processes. We will cover the full workflow of a 2DES experiment and provide an overview of the various experimental configurations currently in use. Common challenges related to data interpretation, reproducibility, and instrumental limitations will be discussed, along with ongoing efforts to address these issues. Technical aspects will be illustrated through specific examples across different (nano)material classes, highlighting both the strengths of the technique and its current limitations. We will conclude by outlining future directions and potential breakthroughs in the application of 2DES to nanoscale and quantum-enabled materials.

12.30 p.m. — Lunch at the Camping's restaurant

2.00 p.m. - 4.00 p.m. — Kayak on Lake Iseo in Sporting Lido Sassabanek

6.30 p.m. – 7.30 p.m. — "Futuro Materiale" | Public lecture by Luca Beverina, University of Milano-Bicocca, at Berlucchi winery

6.30 p.m. - 11.00 p.m. — Guided tour to Berlucchi wine cellars and gala dinner with best poster award and attendance certificate ceremony

FRIDAY 3rd OCTOBER

Daytime — Participants' departure