

Corsi brevi organizzati dal DSCM - 2025|2026

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Nanocellulose: chemistry and advanced materials applications

Prof. Alessandra Operamolla, University of Pisa

This advanced course explores recent discoveries on the fundamental and practical properties of cellulose-derived nanoparticles. Cellulose is a renewable resource and the most abundant polymer on Earth. With rapid progress in the field and growing interest from both scientific and industrial sectors, the course gives the perspective of the organic chemist on the development of new materials from nanocellulose, with an eye to applications in materials science and bioelectronics. The teacher is a pioneer in the field, among the first to apply cellulose nanoparticles—such as cellulose nanocrystals and microfibrils to bioelectronic devices, and an expert in chemical manipulation of nanocellulose. The course offers a comprehensive introduction to cellulose and core techniques, followed by examples on the unique properties and diverse applications of nanocellulose.

Life Cycle Assessment (LCA) within the chemical industry

Prof. Daniele Cespi, University of Bologna

The lecture introduces the principles and background of Life Cycle Assessment (LCA), emphasizing both the direct and indirect environmental impacts of industrial processes. It traces the initial efforts toward the development and standardization of LCA, leading to its formal definition and the establishment of its methodological framework. Various impact assessment methods—such as carbon footprint, water footprint, and ReCiPe 2016—are presented, along with an overview of the critical review process. The strengths and limitations of the LCA methodology are also discussed. Finally, the lecture explores the intersection of Green Chemistry and LCA, highlighting practical applications within the chemical industry.

Talking Science for PhDs: how to improve your presentation skills in and out of the lab

Dr. Marco Carlotti, Researcher, University of Pisa

Communicating your research (or anything else in the world of science and beyond) is of paramount importance nowadays, especially for young researchers, whether they decide to pursue a career in academia or industry. A good presentation, at a conference as much as at a job interview, can be an amazing tool to make good and lasting impressions on your peers. During their formation, however, not many students (and PhD students) actively engage in activities devoted to improving their communication skills. Preparing and practicing presentations often can help, especially in making one feel at ease when talking in front of an audience, but rarely one has the occasion to study and incorporate style elements from the world of storytelling and theater that can really make a difference when delivering a message. In this course, we will discuss together how to improve the effectiveness of several form of communication common in the scientific world. We will do this by analyzing different storytelling elements and styles, understanding how they work and how you can implement them to develop the most suitable presentation style for yourself.

In situ and operando application of vibrational and electronic spectroscopies

Dr. Matteo Signorile, Researcher, University of Turin

The use of in situ and operando spectroscopic techniques is steadily increasing, owing to their ability to probe the structural and electronic properties of materials under realistic working conditions. This class will provide an overview of key vibrational (e.g. IR, Raman) and electronic (e.g. UV-Vis, XAS) spectroscopies, emphasizing their capabilities in capturing dynamic processes in catalysis, energy storage, and materials science; we will explore the fundamental principles, instrumentation, and data interpretation strategies. Through selected literature examples, the class will highlight how these techniques contribute to mechanistic understanding and real-time monitoring of chemical transformations in both model and realistic systems.

Molecular Dynamics Approaches for Exploring Supramolecular Systems: Theory and Applications

Dr. Laura Milena Pedraza Gonzalez, Researcher, University of Pisa

This course provides a comprehensive introduction to molecular dynamics (MD) simulations, with a focus on their application to supramolecular systems. Aimed at PhD students across all areas of chemistry, the program covers the fundamentals of classical MD (including force fields, thermostats, and simulation setup) alongside trajectory analysis, comparison with experimental observables, and assessment of reproducibility of results. The course will also introduce enhanced sampling methods, developed to estimate free energies and overcome the time and length scale limitations of classical MD. Case studies will highlight the versatility of MD across different chemical disciplines.

Recent developments in $^{17}\text{O}/^{18}\text{O}$ isotopic labeling & applications in analytical sciences

Dr. Danielle Laurencin, CNRS Researcher, Institut Charles Gerhardt in Montpellier (France)

Oxygen is the most abundant element at the surface of our planet, where it is found in both living organisms and inert matter. In Chemistry, it is a key element, which is capable to bind to all the other atoms of the periodic table, through different types of bonds (e.g. covalent, ionic, coordination, hydrogen or even halogen bonds). In order to study in detail the nature and reactivity of these bonds, advanced analytical tools like mass spectrometry or NMR are needed. Yet, these rely on the stable isotopes of oxygen, ^{17}O and ^{18}O , both of which have low natural abundances (0.04% and 0.2%, respectively).

The purpose of this series of lectures will be:

- (i) to provide insight into the recent progress made in $^{17}\text{O}/^{18}\text{O}$ isotopic labeling, using advanced synthetic approaches (e.g. mechanochemistry);
- (ii) to show how thanks to these innovative labeling schemes, it is now possible to push forward the study of oxygen bonding environments in molecules and materials using advanced analytical tools, especially ^{17}O solid-state NMR spectroscopy;

(iii) to illustrate how these synthetic and spectroscopic developments open new perspectives in the investigations of materials being developed for applications in healthcare (eg bone-repair) or environmental sciences (eg carbon-capture).

Advanced polymerization techniques for soft materials with diverse high-demanding applications

Dr. Elisa Guazzelli, Researcher, University of Pisa

The course provides an overview of modern polymerization methods that enable the design of advanced polymeric materials with precise architecture and tailored properties. The focus will be on controlled/living radical polymerization techniques, including Atom Transfer Radical Polymerization (ATRP), Reversible Addition–Fragmentation Chain Transfer (RAFT), and Nitroxide-Mediated Polymerization (NMP), alongside other strategies including polymerization induced self-assembly, click chemistry, photopolymerization and enzyme-catalyzed polymerization. Case studies will illustrate how these polymerization approaches allow the preparation of engineered soft materials with diverse high-demanding applications such as biomedicine, energy, and functional coatings.

Communicating and disseminating research results: organization of a scientific event

Prof. Elisa Martinelli, Prof. Fabio Di Francesco, University of Pisa

A laboratory-practical course aiming at providing students with the knowledge and experience necessary for the organization of an international scientific dissemination event. The course will be followed by the allocation of practical tasks: the involved students will live the experience of taking part in the scientific committee of an international scientific conference. Students will be guided by the teachers in all stages of the organization process, and they will have the opportunity to test their acquired skills. Divided into groups, they will be engaged in the following steps: - determining the theme and scope of the conference;

- establishing a timeline outlining the key milestones and deliverables in the conference planning process;
- developing a realistic and feasible budget plan, and raising funds;
- choosing a suitable venue, taking into account capacity, accessibility and cost, and ensuring that the venue is equipped with the necessary facilities, and catering services;
- individuating and inviting plenary and keynote speakers to be involved in the conference, and ensuring that and that their travel and lodging expenses are covered;
- defining a detailed program of events, session titles, and speaker names, ensuring that it is in alignment with the DSCM themes and objectives, and with gender balance, and provides opportunities for networking and discussion;
- spreading the event through various channels, ensuring that the conference website is constantly up-to-date and provides all the necessary information;
- managing the logistics aspects;
- leading the conference according to the established program and timeline, facilitating networking opportunities and a positive experience for the participants;
- follow up with participants after the conference to obtain feedback, evaluate the strengths of the event, and understand aspect which could be improved with a view to other future events.