



## DEPARTMENT OF CHEMISTRY

The Department of Chemistry prides itself in producing highly skilled scientists in the field of Chemistry, capable of responding to current and future challenges in Chemistry at both national and international levels.

The Department offers graduate programmes at the Master (M.Sc.) and Doctoral (Ph.D.) level.

### **Chemistry Graduate Programme at the University of Cyprus**

At present, 60 postgraduate students are enrolled in the graduate programme, 37 of whom are at the Doctoral level. The Chemistry Department has already awarded 51 Ph.D. degrees and 59 M.Sc. degrees.

**Admission to the Graduate Programme** The Department admits graduate students every year at the M.Sc. and Ph.D. levels. The applications are submitted to the Secretariat of the Department and are examined by a three-member faculty Graduate Studies Committee (GSC).

For details on the application procedure and evaluation of candidates, please refer to the Admission and Attendance Regulations – Application Requirements or please consult the Graduate School (tel.: 22894021/44) or the Department's Secretariat.

In addition to the general application requirements, candidates are requested to submit a cover letter explaining the reasons they wish to enter the Chemistry Graduate Programme and to indicate the research area(s) of their interest(s).

### **Financial Support**

The University of Cyprus provides financial assistance to Chemistry postgraduate students in the form of teaching assistantships. Moreover, the postgraduate students can be supported financially through research programmes in Cyprus or abroad for research work carried out within their Ph.D. or M.Sc. studies.

### **Credit Transfer from other Universities / Previous Studies**

The Chemistry Graduate Programme (M.Sc. and Ph.D. levels) includes both classroom courses and bibliographical studies, totalling 60 ECTS. Doctoral students holding an M.Sc. degree from another university may be credited part or all of the 60 ECTS after examination and recommendation by the GSC and approval by the Departmental Council. Moreover, doctoral students may spend up to one calendar year at universities abroad under student exchange programmes. M.Sc. students may attend courses at universities abroad corresponding to a maximum of 20 ECTS. Graduate students may be credited with up to 15 ECTS for courses attended within another graduate programme, after examination and recommendation by the GSC and approval by the Departmental Council.

### **Master of Science (M.Sc.) Degree**

The minimum duration of studies towards an M.Sc. degree is 1.5 years and the maximum duration is 4 years.

### **M.Sc. Requirements**

To obtain an M.Sc. degree, students must successfully complete 120 ECTS of the M.Sc. Chemistry Graduate Programme, and must write an appropriate Diploma Thesis. The required 120 ECTS are obtained by attending 4 of the courses listed below (10 ECTS each), and 2 Graduate Literature Studies (CHE 800 and CHE 810, 10 ECTS each), while 6 research modules carrying 10 ECTS each are credited through research for the Thesis.

### **Course Selection and Approval**

M.Sc. students select their courses in agreement with their research supervisors. Course selection must be approved by the GSC.

### **CHE 800 Literature Study**

M.Sc. students, in agreement with their research supervisors, must enroll in the graduate literature study CHE 800, in the context of which they are required to select a topic from their wider area of expertise, but not from their direct research area. Students must study this topic and present it in the form of a seminar (10 ECTS). The supervision of CHE 800 is carried out by a Chemistry faculty member, who may be the student's supervisor or another Chemistry professor. The central element in the evaluation of CHE 800 is the proven thorough literature survey on the subject of the study, including the latest developments. The examination and grading of this seminar are conducted, after an open presentation, by a two-member committee.

For details on the examination procedure, the grading system and the presentation of the CHE 800 literature study, students may consult the Department's Secretariat.

### **CHE 810 Literature Study**

M.Sc. students, in agreement with their research supervisors, must enroll in the graduate Literature Study CHE 810, in the context of which they are required to select a topic from their immediate research interest (which will be the topic of their Diploma Thesis). Students must study this topic and present it in the form of a seminar (10 ECTS). The student's research supervisor is responsible for supervising CHE 810. The central elements in the evaluation of CHE 810 are: (a) the proven thorough literature survey on the subject of the study, including the latest developments and (b) the understanding of basic concepts immediately relevant to the content of the study. The examination and grading of this seminar are conducted, after an open presentation, by a two-member committee.

For details about the examination procedure, the grading system and the presentation of the CHE 810 literature study, students may consult the Department's Secretariat.

### **M.Sc. Research**

The research topic (experimental or theoretical, or a combination of the two) is chosen in agreement with the research supervisor, aiming at the production of new, original knowledge in chemistry. The originality of the research must be based on the research findings of the student and should be separated from the work of others, indicating clearly the student's personal contribution. The Thesis should include a literature survey, a description of the research methods used, a discussion of the results, conclusions, and literature

references. The Thesis is defended before a three-member examination committee.

For details on the Thesis defence and the composition of the examination committee, please refer to the Admission and Attendance Regulations – Application Requirements or please consult the Graduate School (tel.: 22894021/44) or the Department's Secretariat.

### **Doctor of Philosophy (Ph.D.) Degree**

The minimum duration of studies towards a Ph.D. degree is 3.5 years and the maximum is 8 years.

#### **Ph.D. Requirements**

To obtain a Ph.D. degree, students must successfully complete 240 ECTS of the Doctoral Chemistry Graduate Programme, and must write a Ph.D. Thesis on an approved topic. An essential requirement for the defence of a Ph.D. Thesis is that the student succeeds in the Chemistry Comprehensive Examination, which takes place the latest by the end of the 5th semester. The required 240 ECTS are obtained by attending 4 of the courses (listed below) carrying 10 ECTS each, 2 Graduate Literature Studies (CHE 800 and CHE 810, 10 ECTS each), the Chemistry Department Seminars (CHE 815, 10 ECTS units), while 17 research modules carrying 10 ECTS units each are credited through research for the Ph.D. thesis. Procedures for course selection and the coverage of the Graduate Literature Studies CHE 800 and CHE 810 are the same as those for the M.Sc. Thesis.

#### **Chemistry Department Seminars**

Within CHE 815, Ph.D. students who have passed the Chemistry Comprehensive Examination must attend at least 4 seminars (lectures) per semester for at least 4 semesters. Students must present a seminar within that period. The seminar is graded by a three-member departmental committee appointed by the Chairman of the Department, after the recommendation of the research supervisor. The grade is submitted upon fulfillment of the requirement for attendance at the Departmental Seminars. In case of failure, the student must present a new seminar during the next semester.

#### **Applies to students who enter the Department after January 2013**

Upon their enrollment in the Ph.D. programme, students must register for five semesters, 1 ECTS per semester, for a seminar series (CHE 830 – CHE 834) and attend at least four seminars per semester. Toward the end of their studies, they must register for CHE 835 (5 ECTS) and present a seminar to the Department.

### Ph.D. Research

In addition to the requirements described in the M.Sc. research given above, Ph.D. research should be of very high standard, such that the results are publishable in recognized, peer-reviewed, international research journals. The Chemistry Department demands as a minimum prerequisite towards a Ph.D. degree that candidates have at least one scientific paper either published or accepted for publication in a journal of their research area.

### Ph.D. Comprehensive Examination

This exam, which is an oral examination, should be taken after the student has completed four semesters of graduate studies. Students who already hold an M.Sc. degree from the University of Cyprus or from another university, who have completed all the necessary ECTS and who have produced sufficient research in the first year of studies, may take the Comprehensive Examination at the end of the 2nd semester, at the earliest.

Each student is examined by a three-member committee. The Comprehensive Examination evaluates the level of understanding of the material in the 4 graduate courses that the student attended. The overall research work of the student, as this appears in a written report submitted by the student to the committee, is also evaluated in terms of the level of understanding of the research topic and the quality and quantity of the work.

For more details about the Comprehensive Examination (content of written report, composition and procedure followed by the three-member committee), please consult the Office of Postgraduate Studies, Academic Affairs and Student Welfare Service (tel.: 22894021/61) or the Department's Secretariat.

### Doctoral Dissertation Proposal

After passing the Ph.D. Comprehensive Examination and at least one year before the final defence of the Ph.D. Thesis, the Doctoral Dissertation Proposal must be successfully presented before a three-member Chemistry-faculty committee. The purpose of the Proposal is to examine whether the students have progressed with their research and to evaluate the quality, quantity and novelty of the research work.

### Ph.D. Thesis Defence

The Ph.D. Thesis is submitted and defended only with written permission of the research supervisor and the subsequent submission of the thesis to the Chairman of the Department. The Department demands as a minimum prerequisite towards a Ph.D. degree that the candidates have at least one scientific paper published

or accepted for publication in an international peer-reviewed journal of their own research area. The final examination (defence) of the Doctoral Dissertation is conducted before a five-member examining committee.

For details about the procedure for Ph.D. Thesis defence and the composition of the five-member examining committee, please refer to the Admission and Attendance Regulations – Application Requirements or please consult the Graduate School (tel.: 22894021/61) or the Department's Secretariat.

### Chemistry Graduate Courses (M.Sc. and Ph.D.)

	ECTS
<u>Theoretical Courses</u>	
CHE 610 Physicochemical Methods in Inorganic Chemistry II	10
CHE 611 Physicochemical Methods in Inorganic Chemistry I	10
CHE 612 Physical Chemistry of Polymers	10
CHE 615 Separation Methods and Applications	10
CHE 626 Supramolecular Chemistry	10
CHE 631 Advanced Organic Chemistry I (Organosulfur and Organonitrogen Chemistry)	10
CHE 636 Organic Reactive Intermediates	10
CHE 638 Methods for Structure Characterization	10
CHE 640 Basic Principles of Colloid Chemistry	10
CHE 650 Computational Chemistry	10
CHE 651 Raman Spectroscopy	10
CHE 654 The Theory of the Chemical Bond	10
CHE 670 Heterogeneous Catalysis	10
CHE 681 Biochemical Engineering	10
CHE 690 Synthesis, Characterization and Technology of Polymers	10
CHE 695 Aquatic Chemistry of Heavy Metals	10
CHE 720 Synthesis and Characterization Methods of Inorganic Compounds	10
<u>Graduate and department seminars, Thesis writing</u>	
CHE 800 Literature Study I	10
CHE 810 Literature Study II	10
CHE 815 Chemistry Department Seminars (for Ph.D. level only)	10
CHE 830 Chemistry Department Seminars I	1
CHE 831 Chemistry Department Seminars II	1
CHE 832 Chemistry Department Seminars III	1
CHE 833 Chemistry Department Seminars IV	1
CHE 834 Chemistry Department Seminars V	1
CHE 835 Chemistry Department Seminars VI	5
<u>Research and Thesis writing</u>	
CHE 821-826 M.Sc. Research and M.Sc. Thesis writing	10
CHE 880-899 Ph.D. Research and Ph.D. Thesis writing	10



## Course Descriptions

### CHE 610 Physical Methods in Inorganic Chemistry II

Magnetism: Introduction, Types of Magnetic Behavior, Diamagnetic and Paramagnetic Susceptibility, The Van Vleck Equation, Applications of the Van Vleck Equation to Specific Situations, Curie-Weiss Law, High spin-Low spin equilibrium, Introduction to Neighbor-Neighbor Interactions, Antiferromagnetic Mechanisms, The Heisenberg-Dirac-Van Vleck (HDVV) Approach, Determination of the Values of the Exchange Parameters ( $J$ ) in Dinuclear and Trinuclear Complexes, Ferromagnetic Coupling, Magnetic Properties of High Nuclearity Metal Clusters, Single – Molecule Magnetism Behavior.

Electron Paramagnetic Spectroscopy (EPR): Basic Principles, Hyperfine couplings, Experimental parameters that affect the EPR spectra, examples.

Electrochemistry: Basic Principles, Classification of Electrochemical techniques, Cyclic Voltammetry, Polarography, Chemical Reaction on Electrodes, Electrochemical study of Metal Complexes (experimental parameters that affect electrochemical studies, evaluation of the redox properties of metal complexes and determination of the experimental parameters from cyclic voltammograms and polarograms – E1/2, EPA, EPC, IPA, IPC,  $n$ , etc-reversible, quasi-reversible and irreversible redox processes, examples).

### CHE 611 Physical Methods in Inorganic Chemistry I

- Group Theory: Symmetry, Geometric transformations, Irreducible representations, Character Tables, Applications of group theory to spectroscopy, Molecular orbitals
- Introduction to Spectroscopy: Transitions of atoms and molecules, Selection rules, Determination of concentration and application in the calculation of equilibrium constant and chemical kinetics, Isosbestic points
- Vibrational Spectroscopy: Vibrations in molecules, 3N-6(5) Rule, Selection Rules, Symmetry of vibrations, Normal coordinate analyses, Absorption bands assignment, Group vibrations, Assignment of vibrations by isotopic enrichment, kinetics of fast reactions, RAMAN spectroscopy, Resonance RAMAN, Fingerprinting, Applications of vibrational spectroscopy in bioinorganic models and metalloenzymes
- Nuclear Magnetism Spectroscopy (NMR): Description of NMR experiment, Bloch equations, pulse NMR, NMR quantum mechanics, Relaxation, Inverse recovery and spin echo experiment, chemical shift and nuclear coupling, determination of structure base on chemical shift and nuclear coupling, selective excitation, NOE, Multinuclear NMR, Quadrupolar nuclei, Variable temperature (VT), Reaction rate determination by VT, Two dimensional spectroscopy (2D), 2D-J-resolved, 2D-COSY, 2D-HETCOR, 2D-NOESY, 2D-EXSY and 2D-Inadequate spectroscopy, Kinetics Reaction rate determination by 2D and 1D transfer magnetization, Paramagnetic NMR, Structure Determination, Applications

### CHE 612 Physical Chemistry of Polymers

- Differences between small molecules and macromolecules. Characteristic lengths and relaxation times. Variation of structure, tacticity, homo- and co-polymers, stereochemical effects, ternary structure, polyelectrolytes. Molecular weights and their distributions and methods to measure them. Osmotic pressure, vapor pressure, light, X-ray and neutron-

scattering, ultracentrifugation, viscosity, size exclusion chromatography

- Theoretical studies of the conformations of polymer chains
- Polymers and solvents. Chemical potential and osmotic pressure. Dilute, semi-dilute and concentrated polymer solutions. Good, bad and theta solvents. Flory's solution theory. De Gennes' scaling models. Phase separation in polymeric systems. Polyelectrolytes in solution
- Amorphous phases of polymers. The rubbery state and the theory of rubber elasticity. Melts. Rouse-Zimm dynamic theory in melts. Reptation theory of De Gennes. Glassy phase and the glass transition. Mechanical properties of solids and elastic polymers and viscoelasticity
- Semicrystalline phases. Crystalline lamellae of polymers and the problem of chain reentry. Spherulites, dendrites and other morphologies, liquid crystalline polymers

### CHE 615 Separation Methods and Applications

The main purpose of this course is to familiarize students with the basic concepts of separation science. It examines a number of chromatographic separation methods and their applications in different areas of industry, medicine, environment, forensic science, food science, etc. The separation methods described in this course are the following:

- Gas Chromatography (gas-solid chromatography, gas-liquid chromatography)
- High-Performance Liquid Chromatography (partition chromatography, adsorption or liquid-solid chromatography, ion exchange chromatography, size exclusion or gel chromatography, thin-layer chromatography)
- Capillary Electrophoresis (capillary isoelectric focusing, capillary gel electrophoresis, capillary isotachopheresis, capillary zone electrophoresis, micellar electrokinetic chromatography, capillary electrochromatography)

### CHE 626 Supramolecular Chemistry

Definition and Development of Supramolecular Chemistry; Host-Guest Chemistry; Energetics of Supramolecular Complexes; Experimental Methods; Templates and Self-Assembly; Molecular Devices; Biological Mimics; Liquid Crystals; Micelles, Liposomes, LB-Films; Layer-by-Layer Assembly of Polyelectrolytes; Fullerenes and Carbon Nanotubes.

### CHE 631 Advanced Organic Chemistry I

(Organosulfur and Organonitrogen Chemistry)

Introduction to the organic chemistry of sulfur; di-, tri-, and tetracoordinate sulfur compounds; organosulfur compounds in natural product chemistry and synthesis; organoselenium compounds. Introduction to the organic chemistry of nitrogen; saturated nitrogen compounds (amines, ammonium compounds and nitrogen bases); unsaturated nitrogen compounds (imines, enamines, amides, nitriles, urethanes, ureas, imides and diimides); nitrogen compounds with N-O or N-N bonds (compounds with N-N bonds, oximes, N-oxides, nitroso compounds, nitro compounds).

### CHE 636 Organic Reactive Intermediates

The course examines reactive intermediate compounds of Organic Chemistry and is based on articles from the chemical literature referring to their structure and physicochemical properties and to experimental methods for their preparation,

detection and identification. The compounds examined are neutral species (e.g., diradicals, carbenes and nitrenes, strained alkenes) and ions (carbocations, carbanions).

## **CHE 638 Methods for Structure Characterization**

Principles of crystallographic symmetry. Methods of structure solution and the phase problem: Patterson maps, direct methods, methods of structure convergence. Comparison of X-ray, neutron and electron diffraction. Mössbauer spectroscopy. Spectroscopic methods for the characterization of solid surfaces EXAFS, XPS, UPS.

## **CHE 640 Introduction to Colloid Science**

- Matter in the colloidal state. The main types of colloids. Characteristic phenomena in colloid systems and dispersions. Preparation methods for uniform colloids
- Optical properties of colloids. Scattering of light, X-rays and neutrons. Optical microscopy. Polarized microscope. Electron microscope. Atomic force microscopy and scanning tunnelling microscope
- Kinetic properties of colloids. Diffusion. Viscosity. Rheology. Electrophoresis
- Thermodynamics of interfacial systems. Surface tension. Contact angle. Elementary theory of nucleation, crystal-growth and aggregation
- Interparticle forces in colloidal systems. Van der Waals forces, modern theory of Lifshitz. Modern electric double layer theory. Colloid stability, DLVO theory
- Association colloids. Micelles, liquid-crystalline phases of surfactants. Lamellar phases and vesicles, macro- and microemulsions. Colloidal properties of polymers and biological macromolecules

## **CHE 650 Computational Chemistry**

The course provides an overview of computational methods and their applications in the prediction of physicochemical properties of molecules. Force fields, semi-empirical, DFT and ab initio methods, the most common basis sets and qualitative molecular orbital theory are discussed.

## **CHE 651 Raman Spectroscopy**

- Raman Spectroscopy: Resonance Raman Spectroscopy, Fluorescence Complications, Depolarization Ratios, Absolute Resonance Raman Cross-Sections, Theoretical Calculations, Time-dependent Perturbation Theory, Homogeneous/Inhomogeneous Broadening, Pure dephasing
- Time-Resolved methods: Pump-Probe, Stokes and Anti-Stokes Resonance Raman
- Applications: environmental, biological, charge-transfer, reaction dynamics

## **CHE 654 The Theory of the Chemical Bond**

Schrödinger's equation. Orbitals of one-electron atoms. Approximate methods for many-electron systems. Theory of molecular orbitals. Approximate treatment of molecular orbitals in standard molecular systems. Hückel theory and its applications in conjugated organic molecules. Aromaticity and antiaromaticity. Quantum chemical calculations on molecules with many electrons. Ab initio computational methods.

## **CHE 670 Heterogeneous Catalysis**

- Influence of external mass and heat transport processes on the rate and selectivity of a heterogeneous catalytic reaction.
- Influence of internal mass (diffusion) and heat transport processes within porous catalysts on the rate and selectivity of a catalytic reaction.
- Analysis of experimental rate data of a catalytic reaction.
- Environmental Catalysis: The selective catalytic reduction of NO. From the fundamental research to its applied technology.
- Techniques for studying catalytic reaction mechanisms.

## **CHE 681 Biochemical Engineering**

Introduction: Biochemical Engineering, biotechnology and industry. The chemicals of life: Proteins, nucleic acids, saccharides and lipids. Enzymes and enzyme kinetics. Enzyme applications. Stoichiometry of microbial reactions. Kinetics of substrate consumption, product formation and biomass production in cell cultures. Ideal bioreactors and their modelling.

## **CHE 690 Synthesis, Characterization and Technology of Polymers**

Introduction. Step-growth polymerization – Polycondensation. Free radical chain polymerizations. Free radical chain copolymerizations. Anionic polymerizations. Cationic polymerizations. Propagation-depropagation equilibria in polymerization processes. Stereospecific polymerizations. Chemical reactions on polymers. Functional polymers, block and graft copolymers, model networks. Reactors and processes for homogeneous (single-phase) reactions. Heterogeneous free radical polymerizations. Reactors and processes for heterogeneous ionic polymerizations and reaction injection molding. Reactors and processes for heterogeneous catalytic polymerization.

## **CHE 695 Aquatic Chemistry of Heavy Metals**

This course provides chemical principles that are important to the chemistry of heavy metal ions in natural environments and in particular in natural aquifer systems. The chemical principles that can be applied in order to understand the chemical behavior and the use of chemical thermodynamics for describing reactions of metal ions under natural conditions and in the presence of naturally occurring ligands are reviewed extensively. The course includes introductory chapters on nucleogenesis, metal distribution on the geosphere and characterization of aquatic systems, and a main chapter on the chemistry of metal ions in aquatic solutions. Specific topics such as solid phase solubility, hydrolysis, chloride, carbonate and humate complexation, redox reaction, colloid formation and geochemical reactions are discussed in detail and numerous examples of analytical methods/techniques used in the determination and characterization (speciation) of metal species under environmental conditions are discussed.

## **CHE 720 Methods of Synthesis and Characterization of Inorganic Compounds**

- Synthesis of Inorganic Molecules: Synthetic techniques for the synthesis of inorganic compounds in aqueous solution and organic solvents.
- Synthetic techniques for the synthesis of inorganic compounds in inert atmosphere.
- Characterization of Inorganic Compounds: Characterization in the solid state with infrared, UV-Vis, X-Ray, magnetism.
- Characterization in solution with Electrochemistry, UV-Vis, multinuclear NMR, EPR, magnetism, electrochemical methods.

## Areas of Research

Research in the Department of Chemistry focuses on the following areas:

- Chemistry of Porous Solids
- Physical Chemistry of Colloids and Interfacial Systems
- Computational Chemistry/Molecular Simulation
- Heterogeneous Catalysis/Environmental Catalysis and Technology
- Polymer Synthesis and Characterization
- Synthetic Organic Chemistry
- Fullerene and Supramolecular Chemistry
- Synthetic Inorganic Chemistry
- Materials Chemistry
- Analytical and Environmental Chemistry and Radiochemistry
- Instrumental Analysis
- Molecular Spectroscopy

Chemistry faculty members participate in international research projects and collaborate with several foreign universities and research centers. Members of the Chemistry Department have participated in the past in European Research Programmes. Since 1998, with the participation of Cyprus in the 5th and 6th Framework Programmes of the European Union, the participation of the Chemistry Department in European projects has grown considerably, particularly in the area of Environmental Technology, while increased participation is anticipated in the future. The following list contains representative examples of international research Programmes in which researchers of the Department of Chemistry have collaborated in the past, or are currently participating:

1. Initiative Avicenne (European Union)
2. Human Capital and Mobility (European Union)
3. Training and Mobility of Researchers (European Union)
4. Advanced Stimuli Responsive Materials Projects (JHPC/NEDO, Japan)
5. Research Training Networks (5th Framework Programme)
6. Environment and Sustainable Development (5th Framework Programme)
7. Quality of Life (5th Framework Programme)
8. Growth (5th Framework Programme, European Union)
9. Energy (6th Framework Programme, European Union)
10. Interreg III (7th Framework Programme, European Union)

A number of faculty members in the Department participate in the Greece-Cyprus and Romania-Cyprus Bilateral Research Programmes and in the Programmes of the Cyprus Research Promotion Foundation (including PENEK Programmes). As a result of the applied research carried out in the Department of Chemistry, three patents have already been issued (one European and two USA) and two others have been submitted (European Patent Office).

## Research Laboratory Equipment

The Chemistry postgraduate students conduct their research work in laboratories established by Chemistry faculty members covering the above-mentioned research topics. The equipment in these research laboratories, valued at millions of euros, has been purchased mainly through the University budget (internal funding). In recent years, several pieces of equipment have been purchased through European and Cypriot Research Programmes awarded to the researchers of the Department.

The most important research equipment of the Department of Chemistry is summarized below:

- 300 MHz Avance Bruker NMR Spectrometer
- Xcalibur III Oxford Single-crystal X-ray Diffractometer
- Shimadzu powder X-ray Diffractometer
- Q100 TA Differential Scanning Calorimeter (DSC)
- CHNS-O Eurovector Elemental Analyser
- Princeton Electrochemistry Equipment
- MK I Sherwood Magnetic Balance
- KSV 3000 Langmuir-Blodgett apparatus
- Shimadzu Thermal Gravimetric Analyser (TGA)
- Waters HPLC system with dual pump and UV detector
- Shimadzu FTIR Model IR Prestige-21 with NIR kit and Pike Miracle ATR
- Nox, CO<sub>2</sub>, CO, H<sub>2</sub> and CH<sub>4</sub> Infrared Gas Analyzers
- BET Micromeritics Apparatus
- PicoPlus Molecular Imaging (Agilent) Atomic Force Microscope
- Nanosecond Resonance Raman/TRRR setup
- UV - Vis - NIR (Shimadzu UV-3600 UV-VIS-NIR)
- Computational Chemistry Cluster (PQS) QuantumCube CPU (64-bit Opteron Processors)
- Alpha/beta Radioactivity Proportional Counter



## Research Interests of the Academic Staff

### • Agapios Agapiou, Lecturer

His research is focused on the use and development of Analytical Chemistry methods, especially Instrumental Methods of Analysis, for the qualitative and quantitative determination of Volatile Organic Compounds (VOCs) and their exploitation in novel medical, biochemical, environmental, food, safety and security applications. Specifically, his research includes the following:

- Identification and mapping of the chemical signatures of human presence, emanating from expired air, urine, blood, sweat and other biological excretions.
- Assess and manage solid waste and municipal sewage treatment plants.
- Evaluate indoor air quality (workplaces, car cabins, transportation means, catering facilities, clean rooms, etc.) for exposure to toxic environmental contaminants.
- Monitor the quality of bottled and tap water based on the transfer of VOCs from the packaging to the water or the aging of the water distribution system.
- Early diagnosis and monitoring of various diseases and metabolic disorders such as cancer, diabetes, asthma, liver or kidney failure by correlating VOCs with human metabolic pathways.
- Detection of adulteration, spoilage and authenticity of food based on the spatial modification of the chemical signature.

### • Nikolaos E. Chronakis, Associate Professor

His research is focused on:

The tether-directed remote functionalization of fullerene C<sub>60</sub>.; Synthesis of enantiomerically pure bis- and trisadducts of C<sub>60</sub> with C<sub>2</sub>- and C<sub>3</sub>-symmetrical inherently chiral addition patterns; Study of enantiomerically pure bis- and trisadducts of C<sub>60</sub> with C<sub>2</sub>- and C<sub>3</sub>-symmetrical inherently chiral addition patterns in chiral recognition and in chiral photosensitization; Synthesis of organic materials with well-defined 3D-structures consisted of fullerene building units (Platonic solids, COFs); Synthesis of giant fullerene amphiphiles and study of their self-assembling behaviour in water.

### • Angelos M. Efstathiou, Professor

His research is focused on the field of Heterogeneous Catalysis as a means for solving critical environmental problems (e.g. air and water pollution), problems related to the production of valuable chemical products, and the effective utilization of significant energy-related sources (e.g., natural gas, biomass) towards H<sub>2</sub> production. To achieve these goals, new materials- catalysts must be developed and tested or existing ones improved. The design of new catalytic materials requires fundamental knowledge of the relationships between physicochemical and catalytic (activity/selectivity) surface properties, knowledge of the reaction mechanism and the mechanism of catalyst deactivation.

The main instrumentation that is used in the Heterogeneous Catalysis laboratory at the University of Cyprus for the above described research consists of specially designed gas flow-systems that allow steady-state and transient catalytic experiments to be conducted, quadrupole mass spectrometers, a gas chromatograph, CO, CO<sub>2</sub>, NO<sub>x</sub>, N<sub>2</sub>O and H<sub>2</sub> gas analyzers, in-situ DRIFTS, UV-vis / DRS and Raman flow-cells. Several other catalyst characterization techniques are used in collaboration with other laboratories abroad (e.g., XPS, SEM, HRTEM, Mössbauer, Raman, Photoluminescence). Pioneering research has also been undertaken regarding industrial NO<sub>x</sub> control by the use of H<sub>2</sub> in the low-temperature range of 120-200°C; this has resulted in one USA and three European patents as well as a License Agreement with LINDE ENGINEERING AG for exploitation of these patents.

### • Savvas N. Georgiades, Lecturer

His research interests encompass the areas of Synthetic, Bioorganic and Medicinal Chemistry. More specifically, he is looking into novel and efficient ways for synthetically accessing biologically active small molecules (including natural products), which can be elaborated into therapeutics or chemical probes for the study of biological systems.

One area of focus is the synthesis and investigation of compounds with the potential to act as spatial and temporal modulators of critical cellular signal transduction pathways, for example, the PI3K/PTEN/Akt/FOXO pathway, which provide promise for development of anti-cancer, anti-diabetic or neuroprotective therapies.

Another research focus is the development of new chemical agents that act as stabilizers of DNA G-quadruplexes in human guanine-rich single-stranded DNA sequences, such as the ones from the telomeres or some oncogene-promoter regions. In either case, quadruplex formation within the sequence has shown potential for inhibition of enzymes involved in the progression of cancer.

Various synthetic approaches are used in the lab to carry out the above activities, including conventional solution- and solid-phase synthesis, as well as dynamic and combinatorial.

• **Sophia C. Hayes, Associate Professor**

Her research interests focus on the fundamental understanding of the photochemical and photophysical behavior of a variety of chemical systems in the interactions between molecules and molecules and their environment with the use of molecular spectroscopy. The methods employed include Resonance Raman and time-resolved Resonance Raman spectroscopy, Fluorescence and time-resolved fluorescence spectroscopy. Current research focuses on:

- Characterization of structure and photophysics of conjugated polymers for use in optoelectronic devices.
- Biophysics of peptides as models for protein aggregation and inhibition via interaction with small molecules, relevant to the pathology of neurodegenerative diseases.

• **Constantina P. Kapnissi-Christodoulou, Associate Professor**

Her research interests include the following:

- Development of electrophoretic, chromatographic and electrochromatographic methods for improved achiral and chiral separations of various classes of analytes.
- Use of the hyphenated techniques capillary electrophoresis-mass spectrometry (CE-MS) and ultra performance liquid chromatography-MS-MS (UPLC-MS-MS) for the separation, detection and quantitation of various classes of analytes.
- Application of the optimum separation conditions in biological, natural and food samples.
- Use of enantiomers as diagnostic biomarkers for diseases.
- Determination of the most effective sample pre-treatment methods.
- Synthesis, characterization and use of chiral ionic liquids in capillary electrophoresis for improved separations and greater efficiency.
- Modification of the capillary columns for improved separations.

• **Anastasios D. Keramidas, Professor**

Basic research of transition metal complexes. Bioinorganic chemistry of vanadium, chromium, manganese, iron, molybdenum and selenium, including: synthesis and characterization of model transition metal compounds for the active centre of biomolecules, synthesis and characterization of metal compounds with pharmaceutical properties such as antidiabetic vanadium molecules, and organic selenium compounds with anticancer and antioxidant properties.

Supramolecular chemistry of metal-organic compounds, including: synthesis and characterization of multinuclear metal complexes with defined shape, with Host-Guest properties and novel magnetic and optical properties, synthesis and characterization of supramolecular compounds formed from lipids of transition metal complexes.

• **Panayiotis A. Koutentis, Professor**

Discovery and development of novel heterocyclic chemistry. Sulfur-nitrogen rich heterocycles 1,2,3-dithiazoles and 1,2,6-thiadiazines are under investigation.

Novel conjugated organic polymers based on 1,2,6-thiadiazines; analogues of poly(pyrroles) and poly(thiophenes).

Design, synthesis and characterization of electronically unusual compounds; organic neutral radicals, diradicals, and zwitterion radicals.

• **Epameinondas Leontidis, Professor**

His main research interest is in the area of Physical Chemistry of Colloids and Interfaces. Emphasis is on the study of lipid monolayers on liquid and solid substrates and their interactions with ions and small molecules. The goal is to understand specific ion effects in biophysical and physicochemical systems and in various technological applications, and the use of lipid mono- and multilayers as sensors. The Langmuir-Blodgett and Layer-by-Layer methods are the main tools for these investigations. In other application, the sol-gel method is used to produce novel mesoporous silicate powders for the removal of boron from aqueous solutions. Mesoporous inorganic oxide films for photocatalytic applications are also produced using sol-gel techniques.

There is also activity in the area of computational and theoretical chemistry with the goals of modeling the structure of electrolyte solutions close to surfaces and of understanding salt effects on peptide conformations in solution.

Currently, there is collaboration with the French Center for Separation Chemistry (CEA-Marcoule, France), with the Max Planck Institute for Colloids and Interfaces (Golm, Germany), the University of Graz (Austria), with the University of Patras, the Demokritos Research Institute and the National Research Institute (Greece), with the Department of Microscopy of the Cyprus Institute of Neurology and Genetics, and with many research groups in the University of Cyprus.

• **Athanassios Nicolaides, Associate Professor**

His research interests lie: (a) in the area of organic reactive intermediates with an emphasis on pyramidalized alkenes, carbenes and nitrenes and; (b) in the application of quantum chemical computations to various organic and environmental chemistry problems. He is working in collaboration with researchers in Italy (ISOF-Biofreeradicals) within the COST framework (Action CM0603) to examine the mechanism of oxidation of methionine and other organic substrates. In the area of pyramidalized alkenes his research efforts are directed towards the synthesis of new pyramidalized alkenes and organometallic derivatives of such species with the aim of synthesizing complex polycyclic organic compounds with well-defined rigid geometries.

• **Ioannis Pashalidis, Professor**

Study of the chemical behavior of f element ions in natural aquifer systems and the application of experimental methods for the analysis of adsorbed species on surfaces and colloids. Aqueous nuclear chemistry of actinide ions and environmental alpha radiometry. Study of the interaction of f element ions with chelating agents of clinical use in order to determine and characterize the formed species, assess their behavior under physiological conditions and evaluate their possible use in the decorporation of radionuclides from contaminated persons.

• **Costas S. Patrickios, Professor**

Synthesis, characterization, modelling and applications of functional polymers.



Research is focused on the design and preparation of polymers with improved properties and applications in biotechnology, medicine, optoelectronics, colloidal and environmental chemistry. These polymers are obtained with the polymerization of the appropriate monomer or monomers bearing functional groups with the desired properties. Such properties are the ionic charge (the resulting polymers can be used in protein separation), the nucleophilic character (synthetic polymers mimicking enzymes), the high refractive index (optoelectronic applications), the amphiphilic character (detergency), the very low surface tension (compatibility with the environmentally friendly supercritical carbon dioxide). Other central characteristics of the present polymers are the precise molecular weight (narrow size distribution), the well-defined composition (in case of copolymers) and the controlled architecture (e.g., linear polymers, star polymers or polymer networks; block or random copolymers). These characteristics, which allow the derivation of accurate structure-property relationships, are afforded with the use of "living" synthetic techniques, such as anionic polymerization and group transfer polymerization (GTP), where all polymers grow uniformly during their preparation. The molecular weight and composition of the polymers are characterized using gel permeation chromatography (GPC) and nuclear magnetic resonance (NMR) spectroscopy, respectively. Finally, thermodynamic theories are applied for the prediction of polymer behavior upon aggregation in selective solvents and upon adsorption onto surfaces.

• **Eftychia Pinakoulaki, Assistant Professor**

Her research programme addresses a wide range of fundamental problems in Biophysical/Bioanalytical Chemistry. Fourier transform infrared (FTIR), Attenuated Total Reflection FTIR, time-resolved step-scan FTIR, and resonance Raman spectroscopies are the tools for the investigation of basic mechanisms in Chemistry and Biochemistry.

Current projects include:

- Oxygen sensor proteins EcDOS and BsHemAT: Dynamics and ligand discrimination mechanisms
- Dynamics and catalytic mechanism of Aldoxime dehydratase
- Ligand binding properties and dynamics of thermophilic enzymes
- Nitric oxide activation by NOR and heme-copper cbb3
- Applications of FTIR and Raman spectroscopy in Food Chemistry and Biochemistry

• **Anastasios J. Tasiopoulos, Associate Professor**

Synthesis and Physicochemical characterization of polynuclear metal complexes with potential applications in both Bioinorganic Chemistry, as models for the study of related biomolecules and Materials Science, since below a critical temperature they can function as magnets and are referred to as Single Molecule Magnets (SMMs).

• **Charis R. Theocharis, Professor**

The research interests of his group are: the study of adsorption on porous solids, the surface properties of zeolites, ALPOs, and the reactivity of their surfaces with gases and vapours. Surface properties of the oxides and hydroxides of calcium and magnesium. Chemistry of organic solids.

## Contact Details

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