



Major studies and research projects

From 2009 to 2013, more than 200 national and several dozen international research projects were conducted at the Faculty of Chemistry. They represent major research areas, especially biomedical chemistry, studies on catalytic and photocatalytic processes, synthesis of new functional materials, organic chemistry, and theoretical molecular modelling.

- **New Materials.** Within the framework of projects concerning synthesis of new materials, studies have been conducted on the synthesis of nanostructured polymer assemblies for solar energy conversion. New polymer materials with biomedical uses, e.g. structural materials or carriers for controlled drug delivery systems, were synthesised and explored.
- **Borderlands of Chemistry and Biochemistry Studies.** The characteristics of protein responsible for the processes involved in the development of cancer were described at the Faculty. Moreover, compounds capable of selective inhibition of the inter-protein interactions were sought in order to develop new anticancer therapies. Studies on inhibitors of protein-protein interactions have continued during the project beginning in 2014, financed by a Symphony grant from the NCN. Research related to medical topics included studies on the use of infrared spectroscopic techniques for imaging biochemical changes in endothelial cells caused by stress, pathological changes, and drug treatment.
- **Organic chemistry.** The projects in organic chemistry involved researching carbon-carbon bonding reactions, modelled on natural processes. Moreover, an attempt was made to design asymmetric organic synthesis of chiral compounds, a research project inspired by natural processes.
- **Materials for Clean Technologies.** Under the "Applied Research Program," two research projects are being conducted that aim at developing an innovative modifier for fuel oil combustion and a catalyst for reducing emissions of nitrous oxide, which is a greenhouse gas. The Faculty of Chemistry is a member of the international "Knowledge & Innovation Community Innoenergy," in which it participates in research projects on the following subjects: sustainable power generation, clean coal technologies, the synthesis of new materials for the energy industry, and the process of conversion of energy.
- **Catalysis.** Research in this field includes photocatalytic phenomena, which are extremely important for developing new environmentally friendly technologies. These studies focus on physico-chemical processes that occur on the surface of illuminated semiconductors as well as on functions performed by small particles in light-activated catalytic systems.

Collaboration

Research teams from the Faculty collaborate with national and international institutions: universities, the institutes from the Polish Academy of Sciences, other research institutes, and chemical industry partners (e.g. LOTOS Oil, SK Innovation Co. from South Korea, and Scientific Computing & Modeling from the Netherlands). Together with four other scientific institutions, the Faculty created the KNOW "Matter-Energy-Future" Consortium.

Within the ERA-Chemistry network, under the EU "Open Initiative 2008" programme, the Faculty has an ongoing cooperation with the University of Coimbra in the area of photosensitizers for applications in photocatalysis, medicine, optoelectronics, and solar energy conversion. The Faculty has its representatives on the Steering Committee of the European network of Precision Polymer Materials.



Scholars

From 1998 to 2013, five scholars from the Faculty of Chemistry (Prof. Maria Nowakowska, Prof. Roman Nalewajski, Prof. Zbigniew Sojka, Prof. Grażyna Stochel and Prof. Artur Michalak) were awarded “Jagiellonian Laurel” by the Rector of the University for outstanding scientific achievement.

Prof. Maria Nowakowska – conducts research on nanostructured polymer and hybrid materials. She is the winner of the TEAM programme. Under Prof. Nowakowska’s guidance, methods for detecting live cells were developed. She also guided the development of heparin antagonists, nanostructured bactericidal materials, superparamagnetic nanoparticles for magnetic resonance imaging (MRI), and polymer and hybrid photocatalysts.

Prof. Roman Nalewajski – works on applying information theory in formulating communication theory of chemical bonds. His quantum additions to traditional information measures have allowed for the full “thermodynamic” description of equilibria in molecules and their fragments, as well as the description of their evolution over time.

Prof. Zbigniew Sojka – explores catalysis and surface chemistry of solid materials with the use of molecular modelling and spectroscopic measurements. He participated in developing a new catalytic converter that decomposes nitrous oxide.

Prof. Grażyna Stochel – conducts studies on coordination and bioinorganic chemistry as well as photochemistry in relation to reaction mechanisms and the development of functional materials. She is a co-author of new photosensitizers for photodynamic therapy and microorganism inactivation.

Prof. Artur Michalak – specialises in theoretical chemistry. He is interested in modelling relations between structure and reactivity of catalysts, as well as theoretical research in polymerisation processes. He developed natural orbitals for chemical valence as a method to describe molecular bonds.



Specialisation

- Biological and Medicinal Chemistry
- Catalysis and Environmental Chemistry
- Molecular Modelling
- Spectroscopy
- Advanced Materials and Nanotechnology
- Supramolecular and Coordination Chemistry
- Forensic and Preservation Analysis
- Organic Synthesis

Achievements

Scholars from the Faculty developed a catalytic converter for low-temperature decomposition of nitrous oxide, beginning with laboratory synthesis supported by molecular modelling, and finishing with industrial scale synthesis and tests.

A Faculty research team participated in the MAGMA-Net Consortium, conducting research into magnetic molecular systems having potential uses in alternative methods for recording information.

As a result of their work, Faculty chemists introduced a new interdisciplinary field of research – bioinorganic photochemistry – to scientific literature. Another original contribution the Faculty made to the field of theoretical chemistry is research into the use of information theory in describing chemical bonds and developing descriptions of natural orbitals for chemical valence.

The Jagiellonian University Faculty of Chemistry is also engaged in activities that popularise chemistry and natural sciences. It has organised a series of exhibitions including one devoted to Marie Skłodowska-Curie and one to commemorate the 130th anniversary of the liquefaction of permanent gases.

FACULTY OF CHEMISTRY

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