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Polymer Science in Romania I: "Petru Poni"
Institute of Macromolecular Chemistry, Iasi, Romania

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Most of the polymer research in Romania is done in Bucharest, the capital of the Socialist Republic of Romania, and in Iași. Some polymer research is also carried out in research centers in Medias, Pitești, Sânnicolau, Timișoara, and Rimnicu-Vilcea; the primary objective in these activities is applied polymer research. The present article is concerned with the research in macromolecular science which is carried out in Iași.

Situated in the northeast of Romania, Iași, the old capital of Moldavia, was already established at the beginning of this millennium. When first mentioned in a document in 1408, the settlement was already an economically important local center. It is here that Prince Michael the Brave sanctioned the unification of the three Romanian principalities (i.e., Moldavia, Wallachia, and Transylvania) in 1600. In Iași the signal was given for the 1848 Revolution in the Romanian countries, and it was here that Prince Alexandru Ioan Cuza was elected ruler of Moldavia (1859). These actions were the prelude of the historical act of the formation of the Romanian national state by the unification of Moldavia and Wallachia.

Besides the early events of Romanian history, one can trace in Iași also the beginnings of Romanian culture and higher education. As early as the first half of the 17th century, a school of higher learning, the Vasilian Academy in Greek, was set up in Iași, almost at the same time that the first print started functioning. In 1814 the first school of engineering was opened in Iași. In 1835 the first modern institute of higher learning in Romania, the Michailov Academy, and one year later, the Philharmonic Drama School Conservatoire were established. The first Romanian University was founded in 1860 by Prince Alexandru Ioan Cuza; it is still called by his name today.

Iași is today a city of about 400,000 inhabitants, spread over seven hills; it is full of vitality in spite of its 500-year history. With its University, the Polytechnic Institute, the Medical School, School of Agriculture, and the Conservatoire, Iași is full of academic life in spite of its increasing importance as an industrial center. The chemical industry is represented by an antibiotics factory, a complex synthetic fibers works, and a plastics processing company. Since 1948 Iași has been the seat of the Academy of Sciences of the SR Romania, Branch of Iași.

"Petru Poni" Institute of Macromolecular Chemistry was established in 1964 at the initiative of the President of the Academy, Branch of Iași by separating it from the Institute of Chemistry. The Institute of Chemistry had been founded

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in 1951 by Professor Rada Cernătescu (1894-1958), member of the Academy. Professor Cernătescu was the first 
Director of the Institute. He was followed until 1963 by Dr. 
Ilie Matei (1899-1989), professor at the Polytechnic Insti 
tute, and Dr. Ioan Ungureanu, professor at the University, 
both corresponding members of the Academy. Since 1970 
the leadership of the Institute has been in the hands of 
Dr. Cristofer I. Smionescu, professor at the Polytechnic 
Institute, President of the Academy, Branch of Iași between 
The name of Professor Petru Poni (1841-1925) was given 
to the Institute of Chemistry in 1966. Petru Poni was profes 
sor of chemistry at the University in Iași and is considered 
the founding father of chemical research in Romania. Twice 
he was elected President of the Romanian Academy of 
Sciences. 
In the period 1951-1970 the Institute functioned under 
the auspices of the Academy of SR Romania and between 
1910 and 1975 under the sponsorship of the Ministry of 
Education. In 1975 it was incorporated into the Central Re 
search Institute of Chemistry of the Ministry of Chemical 
Industry along with all other specialized institutes and centers 
dedicated to basic research in chemistry, formerly units of the 
Academy of Sciences of the SR Romania. 
The "Petro Poni" Institute of Macromolecular Chemistry is 
currently concerned with both fundamental and applied re 
search in chemistry and technology of polymers. Considerable 
effort is devoted also to the investigation of the relationship 
between chemical structure and characterization of macro 
molecular compounds, especially new or modified polymers. 
The Institute cooperates with other institutes of the Central 
Research Institute of Chemistry as well as with other aca 
demic institutions. Cooperation includes research and super 
sision of graduate and undergraduate students in chemistry 
and technology of macromolecular compounds. Several 
members of the Institute are also instructors or lecturers at 
the Polytechnic Institute of Iași. The Macromolecular Insti 
tute has its own Ph.D. program and more than 50 Ph.D's 
have graduated since 1969 when the program was started. 
The Institute has also close cooperation with industry, 
assisting, on a contractual basis, in solving specific problems. 
The Institute has over 150 graduated employees (chemists, 
chemical engineers, physicists, and mathematicians); 40 have 
doctoral or doctor-engineer degrees; an equal number are 
technicians. The Institute is divided into five research labor 
atories, each with at least 20 graduates; one section consists 
of a research laboratory and a research group which is con 
cerned with analysis. The laboratories are subdivided into 
research groups. 
One of the research laboratories of the Institute is the 
Laboratory of Fibers and Natural Macromolecules headed by 
Dr. Viorica Rusan. It is concerned with the separation of 
natural polymers from a biomass; these polymers are then 
modified by chemical, biochemical, or thermomechanical 
methods, and their utility as specialty fibers is being investi 
gated. A new method was developed for an upgrading of the 
phytomass in a sequence of steps which can be adjusted 
according to the origin of the raw material and utilization 
of the final products. The method is based on the separation of 
the primary components (cellulose and lignin) after the ex 
traction of other byproducts (pigments, alkaloids, oils, inal, 
lepenes, proteins, polyphenols, and hemicelluloses). Efforts 
are being made to convert the byproducts into different use 
ful products such as resins, organic fertilizers, sugars, and 
biologically active compounds. Cellulose is modified by 
sensitization or grafting. Lignin separated as lignosulphonate 
is a byproduct in papermaking; it is investigated as a potential 
starting material for adhesives, soluble organic fertilizers, and 
surfactants. Investigations are being carried out to develop 
specialty fibers, especially new versions of carbon fibers. 
Investigations are also being carried out for the design of new 
 adhesive compositions and composites (interpenetrating net 
works) based on cellulosic fibers and synthetic fibers in the 
principal of nonwoven materials. The scientific results of the 
laboratory are published primarily in "Cellulose Chemistry 
and Technology," an international journal founded by 
Professor Cristofer Simionescu in 1965; it has an international 
editorial board (A. Bjorkman, H. F. Mark, B. Rahnby, K. Kratzl, 
T. E. Timell, et al.) and is published by the Academy of 
Sciences of the SR Romania. 

Alexandru Ioan-Cuza University, Iași. 

The Laboratory on Semiconducting Polymers and Plasma 
Research headed by Dr. Ioan I. Negulescu is involved in two 
areas of research: (a) synthesis and characterization of 
amolecular compounds with specific electric properties 
and (b) synthesis and/or modification of polymers by means 
of electric (glow) discharges. 
The investigation of polymers with special electric proper 
ties is focused on (i) polymeric materials with (semi-)con 
ducting characteristics and (ii) photoconducting polymers. 
Conjugated polymers, obtained by polymerization of various 
acetylene monomers, are used as model compounds for the 
investigation of conducting polymers. Special attention is 
being paid to the relationship between chain configuration 
and electric or magnetic properties. Modification of poly 
mers, such as the dehydrochlorination of PVC in the pre 
ence of phase transfer catalysts, is used as one way to obtain 
amolecular compounds with blocks of conjugation along the 
polymer chain. 
Polymeric photoconductors are being synthesized from 
monomers with anthracene, perylene threne, or carbazole 
groups and their derivatives in the molecule. Macromolecu 
lar charge transfer complexes, formed between polymeric 
donors such as polymers with carbazole groups, and macro 
molecular acceptors such as fluorocarbon-containing polymers 
are also being studied as photoconducting materials.
Reactions in glow discharges (cold plasma) are being investigated in order to obtain films of polymers from a great variety of organic compounds, usually labeled as unpolymerizable substances. Efforts are also being made to impart new characteristics to existing polymeric materials. Part of these activities is concerned with the origin of life. A new theory has been proposed, i.e., a cold theory of the origin of life (C. I. Simionescu and F. Drisc), which states that the functional protoproteins appeared on cold surfaces under the action of electrical discharges through recombination of active species generated from methane, ammonia, and water.

In the Laboratory of Polycondensation under the leadership of Dr. Florin Popescu is concerned with the synthesis of polymers by polycondensation processes. The products have improved thermal stability or are materials with low flammability and with good adhesive and dielectric properties.

Direct polycondensation using phosphorus intermediates is being investigated for the synthesis of acrylamide polymers under mild conditions. Reaction conditions are carefully investigated in order to achieve optimum yields and high solution viscosities. Thermoplastic polymers (aromatic polyamides) are being synthesized starting from aromatic diamines and anhydrides of aromatic tri- and tetra-carboxylic acids. Polyamidimides, poly(esterimides), and polyurethane-imides are also being synthesized from heterocyclic diamines with benzimidazole or benzotriazole units and aromatic dicarboxylic acid chlorides.

Heterocyclic diamines are also being used as chain extenders for obtaining heterocyclic polyurethanes which decompose at a somewhat higher temperature than classical polyesteror polyurethane.

The synthesis of aromatic polyamides is being studied by polycondensation of the corresponding intermediates in order to obtain engineering plastics with good thermal and dimensional stability.

Polycondensation of monomers containing phosphorus and halogens is being investigated from the point of view of obtaining new ion-exchange resins, polyelectrolytes, and flame-retardant or fire-extinguishing polymers. Reactions of the phosphorous atoms on the backbone or side chains are studied to form amides or esters of various oxygenated phosphorous acids.

Research in this laboratory is also being done in attempts to obtain aliphatic copolymers intended as thermal-heates in industrial processes which require the assembly of different items by thermocollage.

The activity of the Section of Polyaddition and Structure of Polymers with Dr. Adrian Caracuca as its head involves the synthesis of polymers through addition reactions of isocyanates, studies of the fine points of the structure of PVC, thermal degradation (pyrolysis) of polymeric wastes, and the analysis of polymers.

The main problem in the group involves the study of the reactions of 4,4'-dibenzyldisocyanate for the synthesis of different types of polyurethanes. This monomer was synthesized in the early 1960's by Professor Ilie Matei and industrialized in the 1970s. The Romanian polyurethane industry is based on 4,4'-dibenzyldisocyanate. Reaction of the isomers of this monomer and of the corresponding diamines, i.e., 2,3', 2,4', (or 4,4') diamino dibenzyl, are also being investigated for the synthesis of aromatic polyamides, polyimides, polyurethane ionomers, or other heterocyclic macromolecular compounds, such as polyurethane-parabanic acids or poly(parabanic acids).

The relationship between the thermal stability of PVC and the types and amounts of structural defects in the PVC chains is also being investigated in this Section. Efforts are being made to improve the thermal characteristics of PVC by introducing reactive groups during its synthesis followed by modification of the polymer chains through reactive groups in order to obtain stable graft copolymers or block copolymers.

Thermal degradation of polymers is also being investigated with the objective of upgrading polymeric wastes of various types (polystyrene, vulcanized rubber, etc.) through pyrolysis.

The activity of the research group of Polymer Structure and Physics within the Section is led by Dr. Virgil Birloiu; it is involved in studying several aspects in the following areas of spectroscopy: NMR, IR, and UV-Visible spectroscopy for the determination of molecular structure; elemental analysis and analysis for functional groups; applications of mathematical and electronic computation methods; electrical and thermal properties of polymers; polymer photochemistry and photophysics (photopolymers applied as photoresists and photoconductivity in polymers).

The Laboratory of Chemical Reactions on Polymers under Adria Caraci is concerned with the modification of polymers as adsorbing, hydrophilic acrylonitrile exchangers, macroscopic supports for enzyme immobilization and for chromatography; water-soluble polymers are developed as flocculants, coagulants, protective colloids, additives for filtration processes and tertiary formation, anticorrosion, additives for drug formulations and anticorrosion agents, as well as for microencapsulation of insecticides or pesticides (malathion, disulfoton).

Styrene-divinylbenzene matrices with large-size and super-large pores are currently prepared using a mixture of dienes as porogenic agents. The effects of dilution, degree of crosslinking, and the effect of diluents on the porosity and on the coefficients of uptake, the specific surface area, and the average pore diameters are being studied in order to elucidate the manner in which inert compounds contribute to the formation of porous networks.

Various reactions are also being carried out on these cross-linked matrices. Especially studied are chloromethylation with monochloromethyl ether or 1,1-bis(chloromethyl)butane followed by amination in order to produce strongly basic anion exchanger resins. Morphological transformations which occur as a result of these reactions are also being analyzed by determining the porosity and the surface area by SEM.

Crosslinked acrylic copolymers bearing amino or carboxylic acid functional groups are being synthesized and used as supports for biologically active proteins.

The main interest of the Laboratory of Elemental-Organic Polymers with Dr. Mihai Marcu is on organohalogenes and the synthesis of polyorganosilanes (silicones). Both aliphatic and alicyclic silanes are the starting monomers for a series of technical products, i.e., oils, emulsions, and elastomers, for which the technologies are being established. Another area of investigation is the synthesis and characterization of macromolecular chelates. Attention is
being given also to various organoaluminum derivatives which are being tested as polymerization initiators for vinyl or acetylenic monomers.

The Macromolecular Institute participates in international cooperations coordinated by the Academy of Sciences of SR Romania. Many distinguished scientists active in polymer science worldwide have visited the Institute in the past 25 years.

The Institute has organized or cooperated in the organization of significant national and international scientific meetings in the field of natural and synthetic polymers, such as the 29th IUPAC Macromolecular Symposium, MACRO '83, which was held in Bucharest. International symposia in Iași have been held under the title "Cellulose Chemistry and Technology."

The Institute of Macromolecular Chemistry in Iași and the Academy of Sciences of the SR Romania, Iași Branch, were the host of the first U.S.-Romania Seminar on Polymer Chemistry in 1978 and participated in the second U.S.-Romanian Seminar which was held in 1983 in Bucharest.

Several scientists from the Institute are members of foreign academies and scientific societies. Members of the Institute are also represented on editorial boards of journals on macromolecular science.