

1982

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Vogl, Otto; Otsu, T.; and Hatada, K., "Centers of Polymer Research; Polymer Science in Osaka, Japan: Part I" (1982). *Polymer News*. 80.

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Polymer Science in Osaka, Japan: Part 1.

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Koichi Hatada

OSAKA UNIVERSITY

Osaka is located in the heart of the Japanese Islands and has been the commercial and economic center of Japan for centuries. Osaka University was founded in 1931 as a national university, initially with the Faculties of Medicine and Science, and since then has grown rapidly. It has now eleven faculties, the College of General Education, five Research Institutes, three University hospitals, a Central University Library, and three campuses (Toyonaka, Suita and Nakanoshima) with 12,000 students. Polymer research at Osaka University is carried out at the Department of Macromolecular Science, Faculty of Science, the Faculty of Engineering, the Faculty of Engineering Science, the Institute of Scientific and Industrial Research and the Institute for Protein Research.

TOYONAKA CAMPUS

Faculty of Science

Department of Macromolecular Science—The Faculty of Science at Osaka University has a component devoted to the fundamental studies of macromolecular systems and to education in polymer science and technology. The department was named Kobunshi Gakka

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Polymer News, 1982, Vol. 8, pp. 185-187
 0032-3918/82/0806-0185\$6.50/0

which means Department of Polymer Science, or, as renamed in 1980, the Department of Macromolecular Science. It started with two research groups and now has five professors, three associate professors, three assistant professors, and nine instructors. About 30 students receive the polymer science Bachelor's of Science degree from the Faculty every year. Research is carried out in several research groups.

Professor Shun-ichi Nozakura is concerned with polymer synthesis and polymer reaction. With Associate Professor Mikiharu Kamachi he is carrying out fundamental studies on radical polymerization, especially of poly(alkyl methacrylate). He is also studying complex formation between propagating radicals and aromatic solvent molecules by kinetic measurement of the absolute rate constants in the polymerization of alkyl methacrylates and vinyl esters. Instructors Yotaro Morishima and Masaoki Furue are studying photochemistry of polymers for the attempted use of utilization of polymers in solar energy conversion. Another group including instructor Akira Harada is investigating the polymer effects of inclusion compounds of cyclodextrin containing polymers.

Professor Akira Nakamura and his research group, Assistant Professor Nobuki Oguni, Instructors Hajime Yasuda and Norikazu Ueyama are interested in metal complexes in synthetic and natural polymers. Dr. Nobuki Oguni is investigating functional polymer-metal complexes which have chiral chelating groups and catalytically active metal centers. Dr. Hajime Yasuda is studying organometallic polymers with unusual structure; complexes of conjugated olefins with transition metals were prepared and their reactivity for selective oligomerization of isoprene was examined. Dr. Norikazu Ueyama is also interested in metalloenzymes and their model compounds, in particular transition metal complexes of functional peptides.

Professor Hiroyuki Tadokoro's group, which includes Associate Professor Yozo Chatani, Assistant Professor Masamichi Kobayashi, Instructor Yasuhiro Takahashi, and Instructor Kohji Tashiro, is carrying out the following studies: (a) Determination of crystal structures of polyethers, polyisobutylene, three forms of poly(vinylidene fluoride), and isotactic poly(methyl methacrylate) (double helix). (b) Normal coordinate treatments of single molecular chain and crystals of polymers. (c) Intra and intermolecular interaction energy calculations to determine the stability of molecular and crystal structure. (d) Clarification of structure-properties relationships, especially those properties closely related to crystal structure, such as modulus of the crystal, piezoelectricity. (e) Solid-state polymerization behavior from the structural viewpoint.

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 Printed in the United States of America



Faculty of Sciences, Toyonaka Campus

Professor Hiroshi Fujita's research is concerned with the understanding of the correlations between dilute solution properties of macromolecules and their structure and conformations. Three topics are of interest: (a) Dimensional and hydrodynamic behavior of linear flexible polymers and the interpretation of the two-parameter theories (with Instructors Takashi Norisuye and Yoshiyuki Einaga), (b) Synthesis of model homo- and copolypeptides and their helix-coil transitions (with Associate Professor Akio Teramoto and Norisuye), (c) Stiff polymers including polysaccharides (with Norisuye and Einaga). Professor Fujita's group is now involved in a comprehensive study of a fungus-produced linear polysaccharide called schizophyllan, which was found to dissolve in water in the form of a very stiff triple helix, similar to native collagen.

Professor Tadao Kotaka joined this faculty recently and is primarily involved in polymer physics. The main objective of his group is to study rheological, mechanical, electrical and thermal properties of bulk polymers. Work is carried out in cooperation with Assistant Professor Hiroshi Ohnuma, Instructor Keiichi Adachi and Instructor Shinsaku Uemura. Studies on multicomponent polymer systems or polymer alloys of various forms including polymer blends, diblock and multiblock copolymers, as well as complex forming interpenetrating polymer networks are now underway. Synthesis, molecular characterization, morphology and design, survey on molecular structure-morphology-property relationships, and development of new functional materials from these polymer alloys are also under investigation. Conducting or semi-conducting linear-chain polymers of the polydiacetylene type are also under study.

Faculty of Engineering Science

Department of Chemistry—Professor Heimei Yuki is studying the fundamental aspects of anionic polymerization with particular emphasis on the stereochemistry of polymerization. In cooperation with Associate Professor Koichi Hatada, Instructors Yoshio Okamoto and Tatsuki Kitayama he is investigating polymerization and copolymerization of α -substituted acrylic acid esters by anionic initiator and clarified the mechanism of stereoregulation in these polymerizations. This work neces-

sitated their work on NMR relaxation of stereoregular polymer and also on the mechanistic study of polymerization of perdeuterated monomers. The asymmetric-selective polymerization of racemic methacrylates and the synthesis of optically active poly(triphenylmethyl methacrylate) was recently developed. The group also studies cationic polymerization of vinyl ether, slow growth polymerization of methacrylates, preparation of poly(β -amino acid) and has been pioneering in the NMR spectroscopy of polymers.

SUITA CAMPUS

Faculty of Engineering

Department of Applied Chemistry—Professor Hiroshi Mikawa and his group, Associate Professor Yasuhiko Shirota and Instructors Masaaki Yokoyama and Takashi Nogami, have been working on the chemical and physical phenomena involving charge transfer and electron transfer processes: (a) Chemical Phenomena in Solution: Studies on the mechanism of thermally and photochemically induced charge transfer polymerization, mechanism of 1:1 alternating radical copolymerization, mechanism of thermal and photochemical reactions of the electron donor and acceptor systems, mechanism of photoionization of molecules with low ionization potentials in solution, spectroscopic and photophysical properties of polymers in solution. (b) Physical Phenomena in Solids: Studies include photophysical properties of exciplex and excimer formation in polymeric materials; mechanism of photocarrier generation in photoconducting polymeric materials, migration of charge carriers in photoconducting polymeric materials and low-molecular-weight organic photoconductors, and a synthetic approach for organic metals.

Professor Shigekazu Kusabayashi is investigating electronic properties of aromatic vinyl polymers, electronic excitation-energy migration, and photoconductivity, especially the photophysical and chemical effects on photoconductivity, and polymerization in liquid crystalline media. These investigations are conducted in cooperation with Associate Professor Ken-ichi Okamoto of Yamaguchi University.



Professor Toshiyuki Shono and Assistant Professor Minoru Tanaka are interested in (a) analysis of microstructures of polymers and (b) synthesis of functional polymers and their application to analytical chemistry. Professor Shono's group is investigating the run number of copolymers including alternating copolymers, and the content of head-to-head linkages in polymers by pyrolysis-gas chromatography.

Department of Petroleum Chemistry—Professor Haruo Matsuda has been working on polymer synthesis, new chemical reactions catalyzed by organometal compounds. In cooperation with Assistant Professor Akira Ninagawa, ringopening polymerization of epoxides catalyzed by organotin or organoantimony compounds is explored as is the synthesis of new types of novolak resins from substituted alkyl phenyl ethers and the development of polymerizable UV-absorbers.

Professor Kiichi Takemoto is interested in the study of functional polymers, particularly the synthesis of a series of nucleic acid analogues. Professor Takemoto, in cooperation with Assistant Professor Koichi Kondo and Instructor Yoshiaki Inaki, has not only carried out work on the synthesis and polymerization of new monomeric compounds, but also has contributed to the knowledge of the properties and the application of these polymers. One of the important scientific activities is the specific base-base interaction between polymers with complementary pendant nucleic acid bases; effects of molecular weight, conformation and solubility are also being studied. Another subject is the study of the polymer structure with functional groups and their polymer-copper complexes. Polymerization of vinyl and diene monomers in deoxycholic acid canals inclusion complexes are studied with Instructor Mikiji Miyata.

Professor Nobutami Kasai with Associate Professor Nobuo Tanaka and Instructors Yasushi Kai and Kunio Miki, are engaged in wide- and small-angle x-ray studies of macromolecules and in structural studies of polymerization initiators. They are also interested in the structure and function of biologically important macromolecules. By x-ray studies, structure determination of

hydrophobic proteins have been investigated especially for biomembranes.

Institute of Scientific and Industrial Research

Professor Koichiro Hayashi is active in radiation chemistry of synthetic and biopolymer systems. His group is led by Associate Professor Masahiro Irie, and Instructors Yukio Yamamoto and Kazuo Kobayashi, who are involved in: Radiation induced solid state polymerization, radiation induced ionic polymerizations, degradation of polymers by radiation, immobilization of enzymes by radiation induced polymerizations, photopolymerizations, and physicochemical study of hemo-proteins. Investigations of pulse radiolysis and laser photolysis of the fundamental processes of radiation and photochemistry of the polymer systems are also being studied. Another area of investigation is the synthesis of photoresponsive polymers, where physical and chemical properties can be reversibly photocontrolled.

Institute for Protein Research

Professor Masao Kakudo, the Director of the Institute since 1971, has directed investigations of all aspects of x-ray diffraction analysis. The Crystallographic Research Center was established in 1978 within the Institute. A number of synthetic and natural organic substances, amino acids, oligopeptides and proteins were investigated. The detailed structure analysis of cytochrome was completed in 1972 and the structure of four proteins including the protein α -amylase from *Aspergillus oryzae* has now been accomplished.

Professor Yoshimasa Kyogoku is working on the relationship between molecular conformation and activity of biopolymers. In collaboration with Instructor Hiromu Sugeta he is investigating complementary hydrogen bonded base pairs of nucleic acid bases by infrared and nuclear magnetic resonance spectroscopy. With Instructor Hideo Akutsu the role of a phospholipid on the stability of the vesicles is being investigated. With Instructor Yuji Kobayashi molecular dynamics of biologically active peptides and small proteins are studied by NMR spectroscopy.