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Polymer Science in Japan: The Hokuriku District and the Remaining Universities of Japan

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Polymer Science in Japan: Universities in Central Japan, the Hokuriku District and the Remaining Universities of Japan

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Japan, a country of almost 120 million people in an area the size of California, has a very extensive system of education and research in polymer science. Based on the education bill of 1948, many new directions of education and research have been established. The system is based on the "research group" koza system and has allowed a number of novel interdisciplinary science developments to proceed rapidly and efficiently. Polymer science and technology was one of the developments; activities are in national, prefectural, municipal, and private universities. In the last three years we have described in nine articles various centers of polymer research in Japan: with A. Nakagima the Kyoto area, with T. Tsuruta, M. Koinuma, A. Abe, and I. Uematsu, three articles on Tokyo; with K. Hatada and T. Otsu, two articles on Osaka, with T. Kunitake and J. Kiji Kyushu, the Chugoku and Shikoku districts; with Y. Yamashita and N. Nagasawa the Nagoya (Chubu) district, with J. Sohma the Hokkaido district; and with T. Yamaguchi, the Tohoku district. A number of universities where polymer science education and research are carried out had been omitted, especially from Central Japan and the Hokuriku district. In a few isolated cases of other parts of Japan, we found that some research and education in polymer science is carried out which should be mentioned here. While we do not claim that one or the other scientist might not have been overlooked, we believe that with this, the tenth presentation on polymer science in Japanese universities, academic research in Japan has been fully covered. What has not been covered, and which should probably be done in some future articles, is research in governmental and municipal research institutes, such as that in Osaka, and, of course, in industrial laboratories.

In eight charts we show Japan and seven individual districts with the universities in which education and research in polymer science and technology are carried out. The universities indicated with (•) have been described previously; those shown with (○) are mentioned in this article. Pictures of selected universities (the University of Tsukuba, Shinshu University, and Gumma University) are shown.

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UNIVERSITIES IN THE HOKURIKU DISTRICT

A number of universities are located in the Hokuriku district, which includes several prefectures along the Japanese seacoast from the Fukui to the Niigata prefecture. In these universities polymer research and teaching in polymer science are carried out. The following universities are located in this district: Kanazawa University, Fukui University, Toyama University, The Technological University of Nagaoka, and Niigata University.

Kanazawa University

In Kanazawa University, research in polymer science is being carried out in the Faculty of Engineering.

Department of Industrial Chemistry: Professor Hiroshi Suda, the head of the Department, with Associate Professor Masatoshi Motoi, is conducting research in the field of polymer synthesis. They are concerned with asymmetric selective polymerization of racemic monomers, ring opening polymer-

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ization and copolymerization of cyclic ethers, and resolution of racemic mixtures with optically active polymers.

Professor Shin-ichiro Ishida with Associate Professor Yoshiaki Nakamoto and Dr. Yukio Hosokawa are studying molecular weight and molecular weight distribution of formaldehyde resins. In addition, they are also interested in separation technology, in particular with new functional membranes.

In another department of Kanazawa University, Professor Masao Shibahara is concerned with the mechanical properties of materials, including polymers. Professor Kyuichiro Tanaka is working on surface technology and is interested specifically in the frictional behavior of polymers.

Fukui University

Fukui University was first established as a school of science and technology of fibers. Polymer science is therefore located primarily in the Faculty of Engineering, in the Departments of Fiber Technology, but also in the Department of Industrial Chemistry.

Department of Industrial Chemistry: Professor Hiroshi Aida, with Associate Professor Toshiyuki Kodaira and Dr. Iwao Takase, is working on the nonsensitized photopolymerization of N-substituted maleimides and the free radical polymerization of nonconjugated dienes and 1,2-disubstituted olefins. They are also interested in studying the preparation and behavior of functional membranes and the thermal degradation of polymers. Associate Professor Akinobu Unishi is involved in polymer synthesis, particularly of soluble heat-resistant polymers and condensation polymers.

Associate Professor Mamoru Nomura is working on the kinetics of multiphase polymerization reactions. Professor Togoro Matsuo, in cooperation with Professor Ichiro Iwata (who belongs to the Institute of Functional Materials) is carrying out research on the behavior of polymer solutions and dispersions by photo- and x-ray scattering; they are also studying the chemical and physical properties of monocrystalline polymers; theoretical problems of rubber elasticity and viscoelasticity are also being investigated.

Department of Fiber Technology: Professor Toshisada Takahashi, with Associate Professor Kenji Sakurai, is conducting research in the field of the crystalline structure of polymers. They are especially interested in crystallization phenomena of polymer blends, the morphology of liquid crystal-forming polymers, and the separation of gas mixtures by polymer membranes.

Professor Kimihiro Suzuki, with Dr. Isao Ikeda, is studying the synthesis of block and graft copolymers by anionic polymerization. Reactions on cellulose and chemical modifications of natural and synthetic polymers are also being investigated. Professor Yoshiharu Nakamura is working on the microstructure and the physical properties of wool fibers, functional gel materials, and the processing of various polymers. Professor Takuji Yamaguchi, in cooperation with Associate Professor Susumu Saeki, is concerned with the physical properties, especially the viscoelastic properties, of polymers.

Associate Professor Shigeru Kunugi is interested in the mechanism of protease reactions. He is also working on the synthesis and application of membranes for enzyme immobilization.

Toyama University

Toyama University is rather large, but only a few scientists

are active in polymer chemistry and technology. At the Faculty of Education, Associate Professor Shigeya Takeuchi is carrying out research on the reaction of urea and carbamic esters with aldehydes, the synthesis of conjugated diacetylenes and their polymerization. Associate Professor Saburo Matsukawa is working on the processing and the technological behavior of cellulosic fibers.

The Technological University of Nagaoka

This university and the Toyohashi University of Technology were established recently; nevertheless, some excellent scientists are involved both in research and in teaching.

The Chemistry Section: Professor Hajime Miyama is interested in the study of new polymeric materials; in cooperation with Associate Professor Nobuyuki Fujii and Dr. Yoshio Nosaka, he is working on the synthesis of biocompatible polymers and on the attachments of enzymes onto biological and synthetic polymers. Photopolymerization technique is also studied in this group.

Professor Teruo Fujimoto, with Associate Professor Yoshinobu Isono, is interested in polymers with multiphase structure, he is working on new biomaterials with mosaic multiphase structures and on polymers that are superphotosensitive. Professor Fujimoto is also interested in the degradation of polymers.

Professor Kiyokazu Imai and Associate Professor Tomoo Shiomi are concerned with the investigation of solvent effects in free radical polymerization, particularly on the microstructure of the polymers. They are also interested in biomaterials and the fixation of enzymes.

Another group, Professor Ichiro Tsubata and Associate Professor Shinnosuke Miyauchi, is involved in the application of new polymers for electronics application.

Niigata University

The research activities in polymer science of Niigata University are based on the early work of Professor Emeritus Kumaichi Okita who was the inspiration for much of the polymer research. As in other universities, the research activities in polymer science are in departments of the Faculty of Engineering.

In the Department of Applied Chemistry, Professor Yasu Sone, with Associate Professor Norio Tsubokawa, is conducting research on polymerization in the presence of carbon black. His group is also concerned with the synthesis of heat-resistant polymers for electrical applications.

Professor Eizo Oikawa is working on the synthesis of chelate-forming polymers and their application as films, and the preparation of membranes for ultrafiltration. Professor Mitsuhiro Fujii, of the Department of Chemical Engineering, is concerned with the electrochemistry of ionene polymers in aqueous solutions.

Professor Takashi Taniguchi, of the Faculty of Education, is studying the microstructure of cell walls of wood. He is also investigating the mechanism of water absorption of wood and the preparation of wood/plastics composites.

UNIVERSITIES OF CENTRAL JAPAN

In Central Japan, in the northern part of the Kanto and also in the Chubu district, there are a number of rather large, new and well established universities. These are the University of Tsukuba, Gumma University, Ibaragi University, Saitama University, Utsunomiya University, the Defense Academy, and Yamanashi University. Shinshu University in Nagano

The University of Tsukuba

Gumma University

Prefecture was already briefly mentioned in an earlier article. We are describing it here again because some of the research groups have now been enlarged and a new Department of Functional Polymer Science has been added.

The University of Tsukuba

The University of Tsukuba was established in 1973 with a unique philosophy: the "Open" university. It has none of the traditional faculty system that is common in all other existing universities in Japan.

Institute of Material Science: Professor Hideki Shirakawa is investigating the synthesis and characterization of conjugated polymers. He is particularly interested in the synthesis of highly (electrically) conducting polymers and is studying their properties, particularly the effect of doping as a function of conductivity. Associate Professor Masuo Aizawa is studying the interaction of biosensors with molecular recognizable polymer membranes. He is also preparing electrically conducting polymers by electrochemical synthesis and is trying to characterize these systems.

Institute of Chemistry: Professor Osamu Kikuchi is working on the theoretical aspect of the structure of biopolymers and the interaction of biopolymers with other materials. Associate Professor Kunio Furusawa is interested in the absorption on polymers and the synthesis, colloid behavior, and application of polymeric microspheres.

Other Institutes: Assistant Professor Yukiko Tagami, who belongs to the *Institute of Physics*, is involved with the study of statistical thermodynamics of polymer solutions. Assistant Professor Etsuo Kokufuta of the *Institute of Applied Biochemistry* is working on the preparation and characterization of protein/polyelectrolyte complexes and the immobilization of microorganisms with polyelectrolyte complexes. In the *Institute of Information Sciences and Electronics*, Professor Yuzuru Fujiwara is concerned with the study of the configurational statistics and stereochemical structure of vinyl polymers by NMR analysis and is preparing an NMR data base for advanced polymer research.

Gumma University

Gumma University was established some time ago as a special school for the chemistry and technology of fibers. The research on polymers is in the Faculty of Engineering.

Department of Polymer Chemistry: Professor Yoshio Nakamura, with Associate Professor Kozo Arai, is investigating the separation capabilities of cellulose and nylon-6 membranes grafted with functional monomers. He is also interested in flammable fibers of low flammability, immobilization of enzymes, and the microstructure of keratin. Professor Yoshitaka Ogiwara, with Associate Professor Ken-ichiro Arai and Dr. Hitoshi Kubota, is studying the photopolymerization of acrylonitrile in the presence of aniline and aniline derivatives. He is also doing fundamental research on the degradation and stabilization of polymers. Professor Yoshiharu Ishii is concerned with the improvement of the properties of fibers and other polymeric materials and their dyeing properties. The work is carried out in cooperation with Assistant Professor Yoshie Tanaka and Dr. Hiromasa Suzuki.

Department of Polymer and Textile Materials: Professor Nobuhiro Kuwahara, with Assistant Professor Satoshi Okubo and Dr. Kenji Hamano, is studying physical properties of polymers. The main subjects include critical phenomena in polymer solutions and their thermodynamic properties. Professor Shigetake Kinoshita, with Assistant Professor Yasushi Saito and Dr. Yuzo Yamamoto, is working on polymer structures, including the mechanism of shrinkage of collagen fiber, the structural analysis of polyurethanes, and the thermal deformation of restretched films.

Professor Akio Sakanishi, in cooperation with Assistant Professor Koji Yamaga and Drs. Tetsuyuki Sasai and Toshiaki Tsuchihashi, is working on the processing of fibers and films. Recent work involves also the study as biomedical threads. Associate Professor Nobuyuki Tanaka and Assistant Professor Motosuke Naoki are investigating the thermal properties of polymers, and conformational effects at the molecular level. Associate Professor Iwao Matsumoto is evaluating viscoelasticity and electroconductivity of fibrous materials.

In addition to these departments, Gumma University has also an Institute of Composite Materials. Professor Hirotaro Kambe, with Associate Professor Takashi Igarashi and Dr. Shingo Kondo, is studying the thermostability of polymeric materials and the mechanism of polymer degradation. Professor Zenjiro Osawa and Assistant Professor Masamichi Kobayashi are also studying the thermal and photochemical degradation of polymers and the effect of singlet oxygen on polymers. Functional composite materials are also being investigated.

Centers of Polymer Research

Ibaragi University

In the *Faculty of Science*, Professor Yoshimi Kurimura is working on the synthesis and reaction of polymeric metal complexes. He is using these complexes to effect nitrogen fixation, and is also looking at other functional properties of such complexes. In the *Faculty of Engineering*, Professor Hideo Nagasaka's group is interested in the mechanism of the development of charges in powders of plastic materials. Better understanding of the development of electroconductivity on stretching of plastic films and the processing of plastic materials are also being investigated. Professor Susumu Okazaki and Associate Professor Yoshihiro Momose are concerned with fluorination of polymers and the change of their properties during fluorination.

In the *College of General Education*, Associate Professor Yoshihito Osada is working on plasma polymerization, polymer-polymer complexation, and functionalization of polymers by mechanochemical means.

Saitama University

In the *Faculty of Science*, Professor Kiyoshige Fukuda, with Associate Professor Yoshio Shibazaki and Dr. Hiroo Nakahara, is doing research on the polymerization of long chain vinyl monomers. This group is also studying the polycondensation of amino acid esters. In the *Faculty of Engineering*, Professor Hiroyuki Nohira, in cooperation with Associate Professors Kazuhiko Saigo, Hisao Miura and Dr. Terunuma, is concerned with research on optically active ion exchange resins, asymmetric absorbents, polymeric catalysts, and microencapsulation of various materials.

Tohoku District

Utsunomiya University

In the *Faculty of Engineering*, Professor Motome Hamajima is working on the synthesis and use of functional oligomers, and is studying molecular weight distribution of polymers and oligomers. Professor Kazuo Haga is concerned with the study of addition polymerization in micelles and with polymer synthesis by solid state ring-opening polymerization.

Defense Academy

Professor Yoshikiyo Urata, with Dr. Kojima, is working on the stability and thermal degradation of polymeric materials. Professor Ryusuke Kono's group is concerned with semiconductors and the sonic properties of selected biopolymers; dielectric relaxation and other properties of polymers are also being studied in his research group.

Yamanashi University

In the *Faculty of Engineering*, Professor Hiromi Kamogawa, with Associate Professor Masato Nanasawa and Dr. Yuichiro Haramoto, is working on the synthesis of photochromic polymers and polymeric catalysts. This group is also interested broadly in the synthesis of functional polymers. Professor Takaaki Tanaka is concerned with the polymerization of monomers in the presence of preformed polymers.

Shinshu University

Shinshu University was established after the Second World War by uniting several professional schools in the Nagano Prefecture (Chubu District). This university has, therefore, campuses not only in the capital city of Nagano, but also in Ueda, Matsumoto, and Ina. Polymer science and technol-

Department of Functional Polymer Science Shinshu University

ogy is located in the *Faculty of Textile Science and Technology* in Ueda city.

Faculty of Textile Science and Technology: This faculty has recently (in 1978) established a new Department of Functional Polymer Chemistry, which had evolved from another department which had a 70-year history.

Department of Functional Polymer Science: After Professor Nobumasa Hojo, the founder of this department, assumed the presidency of Shinshu University, Professor Kiichi Takemoto of Osaka University (until 1983) has been an adjunct professor at this department; he was working with Associate Professor Hirofusa Shirai and Dr. Kenji Hanabusa. Associate Professor Shirai is interested in the coordination chemistry of polymer/metal complexes, the formation and chemical functionalities of metal/polymer complexes, functional metal-macrocycles (and their polymers), interaction of biopolymers and metal ions, and polymer synthesis in monomer associates. After the retirement of Professor Kosuke Ohki, a biochemist, Associate Professor Yoshiyuki Kondo, is continuing his work on the conformation of bioactive peptides and the structure and properties of biopolymers, especially polypeptides in solution.

Professor Kei Matsuzaki, with Associate Professor Iwao Yamamoto, is concerned with the synthesis and modification of polysaccharides including cellulose and liquid crystalline compounds of transition metals. Professor Saburo Seno, with Assistant Professor Koji Abe and Dr. Ito, is working on the synthesis and characterization of functional polymers and intermacromolecular complexes. Their research interests include also the study of physical and chemical properties of cell membranes.

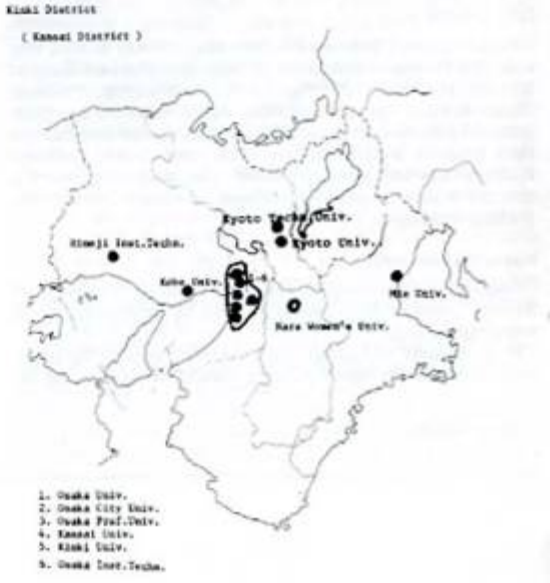
Department of Textile Engineering: Professor Hiroshi Ishikawa is concerned with the research on the fine structure and the physical properties of the silk fibers; he is also interested in molecular motion in poly(amino acids) and the effect of hydrogen bonding on the physical properties of polymers in the solid state. Professor Atsuo Konda is working on the structure and mechanical properties of synthetic fibers.

Department of Textile Chemical Industry: Professor Sadao Hayaski, with Associate Professor Toshihiro Hirai, is studying various aspects of the mechanism of emulsion polymerization, membrane phenomena of polymer complexes, and the formation of polymer/iodine complexes. This research group is also interested in preparing pollution-free paints and adhesives.

Professor Shuji Matsuzawa, in cooperation with Associate Professor Kazuo Yamaura, is involved with the synthesis of stereoregular polymers, flow-induced crystallization of polymers from solution, and the structure of thermoreversible gels. Other subjects of his work are the absorption behavior of polymer films and the behavior at air-solution interfaces. Associate Professor Fukashi Shimizu is working on the interaction between textile fibers and metal ions, mordanting of silk by metal salts, and the dyeing of silk.

Other Departments: In the *Department of Chemical Engineering*, Professor Hideomi Matsuda is working on polymer characterization, the thermodynamic behavior of polymer solutions and of sol-gel transitions of polyolefins in organic solvents. In the *Department of Mechanical Engineering*, Associate Professor Keiji Ohara is working on the development of electric charge on polymer films by friction and the application of electrostats to allevaite this problem; he is also involved in research on triboluminescence. Professor Yoshiyasu Sato belongs to the *Department of Applied Physics*. He is concerned with amorphous polymers and their behavior under large deformation, the rheology of elastomers, and the mechanical properties of heterogeneous elastomers.

Institute of High Polymer Research: Professor Tadao Hayakawa, with Associate Professor Hiroyuki Yamamoto, is working on the synthesis and the chemical properties of poly (amino acids); he is investigating their conformation in the solid state and in solution. Professor Eisaku Iizuka is concerned with the structure and properties of liquid crystalline



materials that are related to living systems; he is particularly interested in thermotropic liquid crystals of macromolecules.

Faculty of Engineering (Nagano City): Associate Professor Masayasu Tasaka is concerned with membrane science. He is working on membrane phenomena in nonisothermal systems, transport phenomena across charged membranes, and in charged mosaic membranes prepared from multiblock copolymers. He is also planning to study chemical reactions in membranes. Assistant Professor Yoshinori Ohta is investigating the effects of plasticizers on the electrical insulating properties of poly(vinyl chloride) films. In the *Faculty of Education*, situated also in Nagano City, Associate Professor Kunio Urushido is interested in cyclopolymerization of allyl esters of unsaturated acids.

Faculty of Science (Matsumoto City): Professor Masatoki Yokoi is carrying out NMR measurements in micellar solutions and is also investigating the physical properties and ionic interactions in electrolyte solutions.

OTHER UNIVERSITIES WITH RESEARCH ACTIVITIES IN POLYMER SCIENCE

A few universities with research activities in polymer science were not mentioned in earlier articles. These include Nara Women's University in Kansai and two universities in Kyushu: Oita University and Kagoshima University.

Nara Women's University

Nara Women's University was first established in 1908 as a girls' teachers' college; in 1949 the school acquired the status of a university.

In the *Faculty of Science*, Professor Fukuo Takemura, together with Dr. Kaoru Iwai, is working on sensitized photopolymerization. This group is also studying the reaction of excited complexes of polymers and their possible utilization.

Oita University

Oita University is located in the industrial city of Oita City near the famous resort town of Beppu on the east coast of Kyushu Island. In the *Faculty of Engineering*, Professor Yasuo Kikuchi's group is working on the structure and properties of polyelectrolyte complexes with special emphasis on their possible biomedical uses. For many years, Professor Norio Okada had been concerned with graft copolymerization; he is now preparing functional membranes by polymer grafting techniques.

Kagoshima University

Kagoshima University is the southernmost university of Kyushu Island in Japan; some research in polymer science is being carried out.

In the *Faculty of Engineering*, Professor Noriyuki Miyauchi, with Associate Professor Mitsuru Akashi, is working on the

synthesis of functional polymers, particularly those that are useful as polymeric drugs, and polymeric catalysts. Paints based on thermosetting resin technology are also being investigated. Professor Hisao Takeshita, with Associate Professor Shirgeru Maeda, is working on polymer chelates, including surface-active agents which are based on polymer chelates.

Professor Atsushi Ikari, with Associate Professor Yasuo Hatate, is involved with vinyl copolymerization in highly viscous systems, suspension polymerization under ultrasoneration conditions, and kinetic studies of slurry polymerization.

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