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Osaka University: A Focus of Polymer Science: 70th Anniversary Celebration

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Celebration of the 70th Anniversary of Osaka University

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OSAKA UNIVERSITY
大阪大学

The celebration of the 70th Anniversary of Osaka University was held under the motto: "Live Locally, Grow Globally" as Osaka University's message to the 21st century.

Osaka University has its roots in two former establishments of education and research: Kaitokudo, founded in 1724 by the citizens of Osaka, and Tekijuku, established in 1838 by Ogata Koan, a prominent medical doctor. In 1931 Osaka University was created as Osaka Imperial University. This year, at the beginning of the 21st century, for two days in May, May 5 and 6, 2001, Osaka University is celebrating its 70th anniversary. This occasion was celebrated by constructing the new Nakanoshima Center; various commemorative publications and other events that were also part of the celebration.

The festivities started on Friday evening May 4, with a Japanese-style gala dinner for invited guests in one of the most famous Japanese restaurants in Osaka, Yamatoya. It is located in the Tennoji Section of Osaka near the Tennoji Temple, a temple of historic distinction. In addition to a delicious Japanese dinner, the guests were entertained with traditional Japanese dances by geishas and performances on the *samisen*, a traditional Japanese guitar.

The commemorative ceremony was opened on Saturday, May 5, 2001, with opening remarks by the president of Osaka University, Tadamitsu Kishimoto. He said:

Tadamitsu Kishimoto
President, Osaka University

Osaka University has supplied the Japanese society with many highly educated women and men. The university is also acknowledged in the international community for its achievements in scientific research. Celebrating the 70th anniversary of its foundation, the university is enlisting all

of its talent to take bold leaps forward. The university's goal is to become a "university of global status" by advancing the university's decade-old motto "Live Locally, Grow Globally."

In the twenty-first century, as information technology develops at a tremendous speed, globalization is also advancing into all areas of our lives. These phenomena necessitate both competition and cooperation on a global scale. For Japan to maintain its status as an advanced nation in this age of rapid change, it must cultivate men and women competent for the 21st century.

What specific goals should Osaka University aim to achieve? Structural reform must take first priority. Osaka University, as a multidisciplinary center of higher learning, has long been dedicated to educating students so they may become citizens rich in both culture and dignity. Now, in addition, the university must focus on providing society with persons who are not only highly skilled, but are also well rounded and practical.

Cooperation and co-prosperity with local communities is also a goal of our mission. To establish a good relationship with the city of Osaka, the university is planning to build a third campus at Nakanoshima, in the heart of downtown Osaka. The new campus will offer new opportunities to the citizens of Osaka for continuing and adult education for all ages and for research activities.

The third goal for Osaka University to attain its new outlook is to "Grow Globally." Our educational and research systems must achieve international standards of the first-rate universities in the world. The university will open its doors to a more international faculty, not just those concerned with language education, in order to encourage world-class scholars to join research activities. This will guarantee the prestige of Osaka University throughout the world.

President Kishimoto's presentation was followed by words of welcome from selected guests and the reading of congratulatory telegrams. Many distinguished guests, faculty, and students were invited to participate in this ceremony. University staff members were also encouraged to take part in the proceedings.

Profile of Osaka University

After the opening, the commemorative lecture was delivered by George Klein, professor since 1957 at the Department of Tumor Biology at the Karolinska Research Institute in Sweden. Professor Klein is one of the world's leading scientists on cancer and immunity. He has received many awards and has been on the selection committee for the Nobel Prize in Medicine. He is not only a scientist who has published numerous scientific papers but he is also involved with general problems of humanity, as can be seen from his recently published books: *Pieta* and *The Atheist and the Holy City*.

Traditional Japanese Dance

After the lecture, Professor Klein received an honorary doctorate in medicine from Osaka University.

The keynote address was followed by the commemorative symposium, entitled *Science and Society in the 21st Century*, held on Saturday morning, May 5, 2001. Professor Kiyokazu Washida, Graduate School of Letters, was the general chairman and Professor Takenori Inoki, Graduate School of Economics, was the session chairman. The panel consisted of a number of speakers who can be considered to represent the various disciplines of today's society. They included Professors George Klein, Department of Tumor Biology, the Karolinska Research Institute, Sweden; Fumiko Yonezawa, Department of Science and Engineering, Keio University, a former Chairman of the Japanese Physics Society; Ken Sakamura, School of Information, Tokyo University; Hirata Oriza, School of

Otto Vogl (l) and George Klein (r)

At the banquet

Otto Vogl

Koichi Hatada Kenichi Takemoto

Literature, Obirin University, an acknowledged young novelist; and Tadamitsu Kishimoto, president of Osaka University.

An international exchange party and banquet of the two-day celebration was held in the Restaurant Sanraku, in the Righa Royal Hotel. The banquet was Western style.

Another highlight of this commemorative celebration was the "University President's Symposium." A number of presidents of universities that have an academic agreement with Osaka University were invited to deepen the international exchange and to discuss the objectives that universities should follow in this new century. During

International Exchange Symposium

this ceremony, Osaka University signed an academic agreement with Peking University.

The Symposium was under the Chairmanship of Koizumi Junji, Professor, School of Human Sciences, Osaka University; it consisted of panelists and discussion panelists. The panelists were Miyanishi Masayoshi (vice president of Osaka University), David Robinson (vice chancellor and president of Monash University, Melbourne, Australia), Denis Favart (prorector of Université Catholique de Louvain, Louvain, Belgium), Daniel Woolf (dean of faculty of Humanities, McMaster University, Hamilton, Ontario, Canada), Wang Zong Guang (executive director of Shanghai University), Hans Wigzell (president of Karolinska Institute, Stockholm, Sweden), Tatchal Sumitra (president of Chulalongkorn University, Bangkok, Thailand), Pornchal Matangksom (president of Mahidol University, Bangkok, Thailand). The discussion panelists were Han Qi De (executive vice president of Peking University, Beijing, China), Hans-Georg Liebich (deputy rektor of Ludwig Maximillians University Munich, Munich, Germany), Jae Yoon Park (president of Pusan National University, Pusan, Korea), and Otto Vogl (Professor Emeritus, University of Massachusetts, Amherst, MA, USA, doctor honoris causa, Osaka University).

During the two-day anniversary celebration, a number of exhibitions and special events were presented.

A Digital Image Theater presentation, "Virtual Tekijuku and Kaitokudo," traced the origins of Osaka University to the 18th and 19th centuries. This period was revived in virtual space using the newest multimedia. It ended with "70 Years of Osaka University History," with the focus on "Our Activities," describing the present status of Osaka University. The presentations also introduced the life and activities of former and current students of Osaka University through talks and recitals.

During the commemorative celebration there also was an exhibition on "The World of Osamu Tezuka," which showed selected examples of precision insect paintings by elementary and secondary school students. Students were awarded prizes for the best paintings.

As mentioned before, Osaka University is very interested in developing an image of global interaction. In one panel discussion, students reported on their exchanges under the international exchange program. Three teams selected from among the university's students reported on their involvement in international exchange activities, experienced in Asia, America, and Europe.

A series of books and pamphlets introducing the various advanced research projects that are performed at Osaka University were presented as a commemorative publication titled "Osaka University: New Century Seminar." Some works included in the publication were: "A Multi-Media Society Created by the Internet," by Professors Miyahara Hideo and Masayuki Murata, and "A Volunteer's Sense—Volunteer Research as a Practice," by Associate Professor Atsumi Tomohide.

Junjiro Kanahori, former president of Osaka University, and Otto Vogl

Yasunori Nishijima, former president, Kyoto University

Osaka University, Suita Campus

Osaka University, Toyonaka Campus

To commemorate Osaka University's 70th anniversary, the Nakanoshima Center was constructed. The center represents a new thrust being developed at the university whose objective is to develop a campus where people from everyday life can receive a lifelong continuing education. The center is expected to be a place where the university and city of Osaka join together and cooperate for the benefit of Osaka's citizens. The center is located on the grounds of the Nakanoshima Campus of Osaka University.

As a finale of the celebration of Osaka University's 70th anniversary, a commemorative concert was performed by the Kansai Philharmonic Orchestra with Fujioka Takao as the conductor. The concert started with a new composition, *Celebration of the 70th Anniversary*. It was followed by the overture to Wagner's: *Meistersinger von Nuernberg* and a gala concert, with selections from *La Boheme, Tosca, The Merry Widow,* and *The Magic Flute*.

After the intermission, more modern and recent pieces of music were presented, beginning with two selections: *The Opening of the Curtain of the 21st Century* and Ryu Yoshimatsu's *Prelude to the 21st Century* (in its first performance in the Kansai region). The concert concluded with Ravel's *Bolero* and Beethoven's Symphony No. 9 (with chorus) *An die Freude*.

In the laboratory

Osaka University

Osaka University (Osaka Daigaku, or Nan Dai) is located on two campuses in the north of Osaka City: one in Toyonaka and the other, in Suita. The administration and the office of the university president are located in Suita.

The Suita Campus (245 acres) is spacious, with rich greenery, and is adjacent to the Expo 70 Commemoration Park. The Toyonaka Campus (105 acres) is located in the Machikaneyama hills, rich in history. The two campuses are connected by a monorail. Both campuses have the facilities necessary for day-by-day life.

Osaka University has 11 schools/faculties: The Schools of Letters, Law, Economics, Science (four departments, including the Department of Macromolecular Science), Pharmaceutical Sciences, Engineering (four departments, including the Department of Applied Science), and Engineering Sciences (four departments, including the Department of Chemical Science and Engineering). Osaka University also has Faculties of Medicine and Dentistry. The last two university presidents came from the Faculty of Medicine. Osaka University also has a School of Health and Sport Science and a Faculty of Language and Culture.

Osaka University also has 12 graduate schools: The Graduate Schools of Letters, Human Sciences, Law, Economics, Science, Medicine, Dentistry, Pharmaceutical Sciences, Engineering, Engineering Sciences, Language and Culture, and International Policy.

About 20,000 students are studying at Osaka University: 12,518 undergraduates and 7,128 graduate students, of which there are 4,143 masters and 2,985 doctoral students. The university is served by a staff of 4,524, including 702 professors and 593 associate professors.

Over the years, Osaka University has had a substantial number of international students from all over the world. Currently, about 5% (853) of the university's students are foreign, and the engineer-

Map of Kansai

ing departments alone have 300 foreign students.

Osaka University has developed, especially over the last five years, extensive interactions with universities abroad. It has agreements with 190 schools and faculties abroad: university agreements with 30 universities in 14 countries; in the USA, with Cornell University, The University of Washington, and Wesleyan College. Osaka University also has 160 interfaculty agreements with universities in 30 countries; 28 of these agreements are between the faculties of Osaka University and colleges and schools in U.S. universities.

The Faculty of Medicine and the Osaka University Hospital

History of Osaka University

The academic origins of Osaka University can be traced to Kaitokudo, a school for citizens of the Edo period, and to Tekijuku, the school of Rangaku. It is believed that the spirit of the university's humanities faculties stemmed from Kaitokudo, while that of the science faculty, including medicine, came from Tekijuku.

Kaitokudo was founded in Amagasaki, Osaka (now Imabashi, Chuo-ku, Osaka City) in 1724 by a group of citizens of Osaka City. The school had a liberal atmosphere, free from the influence of academic schools or dogmas. The spirit was welcomed and supported by Osaka's merchants because it contributed to the upgrading of the cultural and intellectual life in Osaka. Kaitokudo attracted students from all over Japan and made Osaka the academic center of western Japan. Although the school building was burned down during World War II, some books and other literature, about 48,000 items in all, survived the flames and were later presented to Osaka University by the Kaitokudo Commemorating Society. They are now stored in the university's library as "Kaitokudo Bunko."

Tekijuku was founded towards the end of the Edo period, in Osaka's Kawaramachi ward, by Ogata Koan, a doctor and scholar of Rangaku, the only school of Dutch studies at that time. The school was later relocated to present-day Kitahama, Chuo-ku, Osaka City. The school produced an array of talented individuals who pioneered Japan's modern era, mainly in medicine but also in such fields as physics, science, and military science. Among the graduates of Tekijuku were Fukuzawa Yukichi, the founder of Keio University, Omura Masujiro, the father of Japan's modern army, and Takamatsu Ryoan, who played a significant role in the dissemination of modern medicine in Japan. Koan himself was a very competent medical doctor and an excellent educator. His basic ideas about humanity have been inherited by Osaka University and have become its mental backbone. A plan is underway at the university to reproduce the ideas of Kaitokudo and Tekijuku in digital images, store them in a database, and pass them on as a symbol of Osaka University's spirit and ideals.

International House

Osaka Imperial University was inaugurated as the sixth Imperial University in Japan in 1931. It began with two faculties: medicine and science. The School of Engineering was added as a third faculty two years later. Osaka Imperial University changed its name to Osaka University in 1947. In 1949, as a result of the government's reform of its education system, Osaka University started its postwar period with five faculties: science, medicine, engineering, letters, and law. Although it is a National University, Osaka University was established in response to the requests of local industrial circles and citizens. This is reflected in the many faculties that were founded through the financing of voluntary contributors.

Unique and innovative faculties, graduate schools, and research institutes have been established at Osaka University, one after another. They include the School of Engineering Science, the first of its kind in a national university, which has its place between the Schools of Engineering and Science and the School of Human Sciences, which covers psychology, sociology, and education. In 1993, the

Osaka University Hospital was relocated from Nakanoshima in Osaka City to the Suita campus. This completed the implementation of the university's long-cherished plan to integrate all major facilities into the two campuses, the Suita and the Toyonaka campuses.

In 1953, graduate schools were set up in Japanese universities as part of the government's reform program of its education system. All the faculties of Osaka University, which had by then increased to 10, started to create graduate schools. In 1994, the number of graduate schools had reached 12. They include the Graduate School of Language and Culture, an independent graduate school, and the Osaka School of International Public Policy, a cross-faculty and cross-institutional independent graduate school.

Osaka University's long tradition of excellence in physics, which started with Nadaoka Hantaro, the university's first president, and Yukawa Hideki (his treatise was written while at the university), who received the Nobel Prize for physics, still continues at the Graduate School of Science and the Research Center for Nuclear Physics. That is the reason why Osaka University leads Japan's research in the field of particle physics.

Remarkable achievements are also found in the School of Engineering which promotes advanced fundamental research and collaboration with the industrial sector. The School of Engineering Science was established by the fusion of science and technology.

The faculty of Dentistry, developing as an internationally known established school for dental education, research, and clinical care, and the School of Pharmaceutical Sciences for the pursuit of pharmaceutical studies as comprehensive health sciences, also play a very important role.

Advanced research in medical care in the Faculty of Medicine has been drawing attention both from within Japan and from abroad. Japan's first successful heart transplant was carried out at the Osaka University Hospital.

The outstanding achievements of the university's science faculties, graduate schools, and research centers are demonstrated by the fact that in 1998, the university had the third largest number of treatises published in the field of chemistry in the world, and for the last 10 years, has been ranked third in Japan in the number of treatises cited in the scientific journal *Nature*.

The Faculties of Culture, which were established after the war, have also developed remarkably. The School of Letters provides education and research in various new fields beyond the conventional borders of cultural sciences. The School of Law is promoting research linked to a wide range of areas in our society. The School of Human Sciences is a unique center of learning and research that combines cultural, social, and natural sciences. The research carried out at the Graduate School of Language and Culture and the Osaka School of International Public Policy, established in response to the needs of the times, is highly respected within and outside Japan. The School of Economics is known as the Mecca of modern economics in Japan, and research performed there is internationally recognized.

A number of research institutes were also established at Osaka University in rapid succession. In addition to the Research Institute for Microbial Diseases and the Institute of Scientific and Industrial Research, which existed before World War II, the Institute for Protein Research, the Institute of Social and Economic Research, and the Welding Research Institute (the current Joining and Welding Research Institute) were set up. They became independent institutions separate from their parent faculties. Added to these institutes were Nationwide Joint-Use Facilities and Intra-University Joint-Use Facilities. The Research Center for Materials Science under Extreme Conditions was recently built to study and develop new industrial materials. In total, there are 25 centers, research facilities, and laboratories in operation at Osaka University today.

Osaka University and Polymer Science

Polymer science became part of Osaka University early in the development of the university. In Japan and other parts of the world, polymer science was initially concerned with rubber and fiber chemistry and technology. After the war, in 1949, the government of Japan reorganized its education system, and polymer chemistry

Koichi Hatada **Kenichi Takemoto**

began to develop. The universities were organized into teaching departments and research groups. They were headed by a professor (*Kyoju*), assisted by one associate professor (*Jo-kyoju*), and one or two instructors (*Jo-shu*). This system still exists in most universities. Like many National Universities, Osaka has a mandatory retirement age of 63.

In 1948, one of the young scientists and teachers of that time, Shunsuke Murahashi (*Polymer News*, 22(4), 134–135 (1997)), of the Department of Chemistry, began teaching polymer chemistry. He started research and became interested in the development of fibers from poly(vinyl alcohol). He was not the only person at Osaka University who was interested in macromolecules, but he was the most important driving force for the development of polymer chem-

istry. Not only was he interested in polymer synthesis, but he also realized that once the polymer was prepared, it had to be characterized and further understood. He appreciated that an understanding of the structure-properties relationship of the polymer was very important. As a consequence, he foresaw that future work in polymer science, and comprehensive education and research involving synthesis, structure, and properties were an absolute necessity.

In the 1960s Professor Murahashi's chair at the university was divided into five chairs of teaching (*Kozas*), and the Department of Polymer Science was created. It then encompassed not only polymer chemistry but also polymer physical chemistry and physics and also catalysis of polymerization. The chairs were filled, in addition to Murahashi, by Hisaya Tani, Yoichi Ishida, Hiroshi Fujita, and Hiroyuki Tadokoro (*Polymer News*, 23(4), 121–122 (1998)). The Department of Polymer Chemistry was later renamed Department of Macromolecular Science.

In 1996, the educational system at several universities was formed to emphasize the education and training of graduate students. In order to perform wider education in macromolecular science, two chairs were added to the original five chairs in the Department of Macromolecular Science, and the seven chairs were reorganized into three educational groups: (1) polymer synthesis and reactions; (2) polymer structure, properties, and function; and (3) macromolecular assemblies.

From the 1960s to the 1970s, the School of Engineering, in the Department of Applied Chemistry, added *kozas* that were involved in some aspect of polymer science. They were filled by Hiroshi Mikawa and Kiichi Takemoto. One polymer *koza* was newly created as the School of Engineering Science, and Heimei Yuki was appointed *Kyoju*.

We will now discuss the development and progress of the research and education in polymer chemistry at Osaka University based on individual departments and research groups.

Shunsuke Murahashi (*koza* 1) was a typical organic chemist, and always was interested in the synthesis of new polymers. He succeeded in the preparation of poly(vinyl alcohols) of various types of stereochemistry whose stereoregularity ranged from isotactic to syndiotactic. He also became interested in the stereospecific polymerization of vinyl acetate to make stronger poly(vinyl alcohol) fiber. His investigations on vinyl monomer polymerization continued and were extended by his successors, Shunichi Nozakura and Mikiharu Kamachi.

Nozakura succeeded Murahashi's investigation of functional polymers, especially new types of polymers with photochemical activity. Mikiharu Kamachi was Nozakura's successor and more interested in the effects of polymer chain ends on the photochemical and magnetic functions and on new polymer syntheses. He also carried out basic research on radical polymerization using the rotating sector method and ESR spectroscopy, and clarified unsolved problems in the radical polymerization.

Yotaro Morishima and Akira Harada, now professors, worked with Nozakura and Kamachi as associate professors or instructors. In 1995, Morishima was appointed to another chair after the retirement of Professor Kotaka, who will be mentioned later.

In 1998, Akira Harada was appointed to a new chair of molecular assemblies. He is studying the construction of supramolecular polymers using cyclodextrin as a cyclic host component and various polymers as guests. The work has developed into the creation of molecular machines and nanomaterials, using polyrotaxanes and poly atenanes. Additional work in his group is concerned with the preparation of antibodies aiming antibodies as catalysts and antibodies for other functions. Recently, a photoinduced electron transfer on the combining site of monoclonal antibodies for porphyrin derivatives was recognized. Harada also used plasmids (macrocyclic DNA) as building blocks for the construction of polycatenanes.

In 2000, Sadahito Aoshima, who was an associate professor at Tokyo Science University, was appointed to one of the chairs in Polymer Synthesis and Polymer Reaction. He is interested in the synthesis of new functional polymers by living cationic polymerization.

For *koza II*, Hisaya Tani was appointed in the 1960s to a chair of synthetic chemistry in the Department of Polymer Science. Takeo Araki became his *Jo-kyoju* and H. Yasuda the *Jo-shu*. The initial research interests of Tani's group were the synthesis of polypeptides by attempted stereospecific polymerization and oligomerization of D, L-NCA. Tani was also involved in polymers with alkyne units in the main chain. His interests later changed to the polymerization of acetaldehyde, epoxides, methyl methacrylate, and vinyl ethers with organometallic initiators. He attempted to establish a mechanism for acetaldehyde polymerization and its stereospecificity with alkylaluminum complexes.

His successor, Akira Nakamura, studied the synthesis and reaction of transition metal complexes including Mo, Zr, Ta, and Nb. These studies developed the chemistry of metal-thiolate clusters. Nakamura also contributed to the synthesis of many novel reactive metal complexes which could be used as intermediates for catalytic reactions in the fields of organometallic and bio-inorganic materials.

Norikazu Ueyama was appointed to the chair after Nakamura's retirement. Ueyama's research interests include the study of chemical regulation of pp-dp metal-ligand bonds in the active center of metallo-enzymes. He is particularly concerned with the stability of intermediates during the enzymatic reactions. More recently, he has been studying the synthesis of Mo, W-oxidase complexes as novel model compounds, and polymers containing nonnatural metal-complexed amino acids. His goal is the elucidation of metallo-enzymatic catalytic reactions.

Another *koza* (III) was created in the 1960s with Hiroyuki Tadokoro as the Professor. He started studying the structure of crystalline polymers by x-ray diffraction and infrared spectroscopy and became a giant in the determination of polymer structures by

x-ray structure determination. His book on the crystal structure of polymers is a classic.

His successor, the late Masamichi Kobayashi, studied the relationship between polymer structure and polymer properties for crystalline polymers.

Kohji Tashiro was appointed to the chair after the retirement of Kobayashi. After the reorganization of the department, he became one of the holders of the chairs (Polymer Structure) of Macromolecular Assemblies. He combines various techniques for structure determinations to provide the highest possible reliability. The techniques include x-ray diffraction, electron diffraction, neutron scattering, infrared spectroscopy, Raman spectroscopy, and computer simulation. This type of approach allows the determination of complicated structures of many important polymers such as poly(p-phenylene-benzobisoxazole), isotactic polybutene-1 (form II), and ethylene-vinyl alcohol copolymers. He has also worked on ferroelectric phase transitions of vinylidene fluoride copolymers, isothermal crystallization of polyethylene from the melt, solvent-induced crystallization of syndiotactic polystyrene glass, and photo-induced polymerization of diethyl *cis,cis*-muconate.

Yoichi Ishida was the first occupant of *koza* IV, Polymer Physical Chemistry. In 1966, he initiated the study of the dielectric spectroscopy of polymers. He investigated dielectric properties of solid polymers and classified various dielectric relaxation processes into the primary relaxation, the crystalline relaxation process, and secondary processes.

In 1976 Ishida was succeeded by Tadao Kotaka, whose major areas of research were the rheology of multicomponent polymers, the electric properties of conductive polymers, and the chain dynamics of polymers.

Since 1995, Yotaro Morishima became the next holder of the chair. Morishima is interested in the behavior of amphiphilic polyelectrolytes in aqueous solutions, especially the control of preferential intra- or interpolymer association by macromolecular architectures. He prepared unimolecular micelles of hydrophobically modified polysulfonates by selective intra-association of hydrophobic groups. New nanoscopic aggregation of hydrophobic groups of amphiphilic polyelectrolytes were found. Their applications to nanotechnology is being carried out in collaboration with several industrial companies.

After the reorganization in 1996, Keiichiro Adachi was appointed to one (Polymer Physical Chemistry) of the chairs for Polymer Structure, Properties, and Function. He is interested in polymer chain dynamics, especially the dielectric normal mode relaxation observed for polymers having dipole moments proportional to the end-to-end distance of the chains. Using this technique, he established the average relaxation time and mode distribution for fluctuation of the end-to-end distance of polymer chains in solutions and undiluted states of homopolymers and polymer alloys.

In the 1960s, during the period of the creation of several new *kozas* in the department, Hiroshi Fujita became the head of *koza* V. He had worked previously in the United States for AT&T. His specialty became the study of polymer solutions. He believed that properties of polymeric materials must be understood in terms of the molecular structure (or conformation) of the individual polymers and their interactions. The molecular characterization of polymers was deduced from solution properties. The objective of his research was to establish the methodology of molecular characterization from solution properties and also to elucidate the interrelation among the structure (conformation), intermolecular interaction, and various solution properties.

He was succeeded in the chair by Akio Teramoto, who studied in detail the helix-coil transition of polypeptides and the unique properties of concentrated solutions of stiff-chain polymers, polymers with liquid crystallinity and high viscosity, on the basis of molecular parameters determined from dilute solution.

After the retirement of Teramoto, Takashi Norisuye was appointed to the chair originally occupied by Fujita. Now he holds one (Polymer Solution) of the chairs for Polymer Structure, Properties, and Function. The following achievements have been made in his group using several experimental techniques, such as light scattering, small-angle x-ray scattering, ultracentrifugation, viscometry, and polarimetry (or circular dichroism): (1) the quantification of intramolecular excluded-volume effects in polymer; (2) the characterization of the chain stiffness, the intermolecular interaction, and the helical structure of various synthetic and biological polymers; (3) the elucidation of the molecular mechanism of various solution properties (e.g., viscosity, diffusivity, liquid-crystal elasticity, and osmotic compressibility).

The group has provided the most precise and reliable molecular parameters for various polymers and is making continuous efforts to further develop the methodology of the characterization of polymer molecules. The research group is now investigating the effect of the electrostatic interaction on the chain conformation in polyelectrolytes, the architecture–property relationship in regularly branched polymers, and the aggregation behavior of polymers in solution.

When the School of Engineering Science was created in 1961, Heimei Yuki became the Professor in the Department of Chemistry. He had envisioned making and investigating a synthetic polymer with a variety of conformations, as exhibited in polypeptide chains. He concentrated on the stereospecific polymerization of vinyl monomers. In 1964, Koichi Hatada (*Polymer News*, 20(8), 238–239 (1995)), joined his research group as *Jo-shu*. A few years later, in 1968, Yuki and Hatada published a significant paper, in which they described that triphenylmethyl methacrylate gives isotactic polymers, based on the steric requirements of the large triphenyl group. It was believed but not proven that the polymer assumed a helical conformation similar to that of the α-helix of peptide chains. A few years later, Yoshio Okamoto, then a *Jo-shu* in Yuki's and later *Jo-kyoju* in Hatada's group, contributed to the chiral initiation of

the triphenylmethyl methacrylate polymerization to optically active poly(triphenylmethyl methacrylate). Later, as Professor at Nagoya University, he continued his work on synthetic helical polymers based on triarylmethyl methacrylates by their asymmetric polymerization.

In 1981, Hatada succeeded in Yuki's chair. He worked on stereospecific and living polymerization of methacrylate monomers and the characterization of stereoregular polymers. Most of these polymers had narrow molecular weight distributions, but one question remained: How does the helix form and at what degree of polymerization does the polymerization become not only stereo- but also conformationally specific? A practical way to solve this problem was not to continue with the polymerization of highly hindered methacrylates, but with the oligomerization of chloral, which has similar properties, having a monomer with a very large side group, the trichloromethyl group. This led to the study of the oligomerization of chloral, which consisted of the isolation and characterization of individual oligochlorals including their absolute configuration. In the 1990s, Hatada's group started with their goal of isolating and characterizing uniform polymers. In collaboration with Tatsuki Kitayama (*Jo-kyoju*) and Koichi Ute (*Jo-shu*), supercritical fluid chromatography (SFC) was used to isolate polymers of unique molecular weight, which means, without molecular weight distribution, "uniform polymers."

In 1998, Hatada retired and Tatsuki Kitayama became his successor with Koichi Ute as his *Jo-kyoju*. Kitayama continues the work on stereospecific polymerizations to control polymer structure. He prepared heterotactic polymethacrylates and stereoregular polyacrylates by living polymerization, which has led to functional elastomers with amphiphilic blocks. The separation of polymethacrylates according to their tacticity has been achieved and the structural studies of PMMA stereocomplexes have been carried out.

In the Faculty of Engineering, Yoshikazu Hachihama, at the time of Murahashi, was also interested in polymers, but in natural polymers including lignin. In 1965, Hiroshi Mikawa succeeded him as *Kyoju* of the *koza*. Mikawa investigated photoconductivity of poly(N-vinylcarbazole) and related polymers, electrically conducting materials, charge-transfer polymerization of N-vinylcarbazole, and 1:1 alternating copolymers obtained by radical copolymerizations.

In 1986 Yasuhiko Shirota succeeded Mikawa. Over the years he has studied the preparation of novel photo- and electroactive organic materials. He investigated their structures and properties and their possible applications for electronic and optoelectronic devices. His group has prepared and used a wide range of polymer structures, from low-molecular-weight organic compounds to oligomers and polymers with well-defined structures. Of special interest were amorphous materials and molecular gels. Extensively studied were oligothiophenes with well-defined structures and polymers containing pendant oligothiophenes and other 7c-electron systems. In these systems, electrical, photoelectric, photorefractive, charge transport, photochromic, electrochromic, and emission properties as well as other molecular properties were investigated. Electronic and optoelectronic devices were fabricated and their performance as secondary batteries, electrochromic display, holographic display, photovoltaic devices, photorefractive, and other organic electroluminescent devices were studied.

The possibility of creating low-molecular-weight organic resists called "molecular resists" are expected to be important for future nanometer lithography. One aspect of their research is also the field of organic materials science known as "molecular glasses," amorphous glasses stable above room temperature.

In 1969, the Faculty of Engineering added one more chair in polymer chemistry: Kiichi Takemoto was appointed *Kyoju*. He designed systems for the synthesis of functional polymers related to biochemical syntheses and biomaterials. His research group prepared and characterized various synthetic nucleic acids, a pioneering effort at that time. Takemoto's work included the preparation of monomers with nucleic acid bases and their polymerization related to the pairing of nucleic acid bases. He also investigated the clathration between deoxycholic acid and various monomers which produced highly asymmetric polymers with chiral channels.

In 1995, the Faculty of Engineering was reorganized based on the new principle of the concept of the Graduate School of Engineering. At that time, the Department of Material and Life Science was founded. Mikii Miyata was appointed Professor of Molecular Recognition Chemistry. His research interests included supramolecular chemistry related to macromolecules, inclusion compounds with steroidal bile acids, and their derivatives as host–guest complexes. He investigated molecular recognition phenomena based on the establishment of a series of crystal structures of inclusion complexes. He also focused on the chemistry of inclusion compounds to crystal engineering related to supramolecular chemistry. He finally reached the conclusion that the recognition phenomena should be evaluated from the general point of view of the hierarchical structure of materials which exist throughout the universe.

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