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IUPAC 32nd International Congress on Macromolecules "MACRO 88"

Item Type	article;article
Authors	Vogl, Otto;Koide, Naohuki;Kitayama, Tatsuki;Hatada, Koichi
Download date	2024-06-18 06:54:35
Link to Item	https://hdl.handle.net/20.500.14394/23276

Naohuki Koide, Tatsuki Kitayama, Koichi Hatada and Otto Vogl, *IUPAC 32nd International Congress on Macromolecules "MACRO 88"*, *Polymer News*, **14(2)**, 58--62 (1989)

Conference Report

IUPAC 32nd International Symposium on Macromolecules "MACRO 88"

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Kyoto International Conference Hall

The IUPAC 32nd International Symposium on Macromolecules was held from August 1 to 6, 1988 at the Kyoto International Conference Hall, Takaragaike, Kyoto, Japan. The Symposium was organized by the Society of Polymer Science Japan under the chairmanship of Professor Takeo Saegusa of Kyoto University, Kyoto, Japan.

IUPAC International Symposia on Macromolecules have a long history. The first symposium was held in 1948 in Liege, Belgium, the most recent one in 1987, was held in Merseburg, GDR; the 33rd is planned for Montreal, Canada from July 8 to 13 in 1990.

One IUPAC Macromolecular Symposium was held previously in Japan in Tokyo/Kyoto in 1966, 22 years ago. It was the 14th IUPAC International Symposium on Macromolecules.

Kyoto is an excellent location for international meetings; it was the ancient imperial capital of Japan for more than 1,000 years until 1868 and is now a city of 1.5 million inhabitants. Kyoto has been and is still the center of the civilization of Japan with about 2000 temples and shrines. Kyoto has produced and is the home of many art treasures and is considered the spiritual home of culture of all Japanese. Today Kyoto is a cultural and academic center with a number of universities and research institutions. It is also the center of both traditional and modern industries and is the site of many leading venture businesses.

The world famous Kyoto International Conference Hall was opened in 1966 and is among the leading international conference centers in the world.

MACRO 88 attracted over 1600 participants from Japan and abroad. Nearly 500 participants came from 41 foreign countries. The IUPAC 32nd International Symposium for Macromolecules consisted of 3 plenary lectures, 52 invited and 53 session lectures. Over 500 contributed papers were presented in oral form and in over 200 poster presentations. The emphasis of the conference was on specialty polymers particularly high performance polymers and functional polymers including bio-related polymers, as it is believed that such polymeric materials play an essential role in the development of polymers for advanced technologies. In addition, the relation of IUPAC and polymer science was emphasized.

MACRO 88 EXPO was also held at the Event Hall in conjunction with MACRO 88; it was sponsored by the Society of Polymer Science, Japan. MACRO 88 EXPO was an exposition of advanced polymeric materials and scientific instruments and attracted over 50 exhibitors from the Japanese industry. In addition many if not all research groups in polymer science of universities and research institutions presented their image and the newest results of their work.

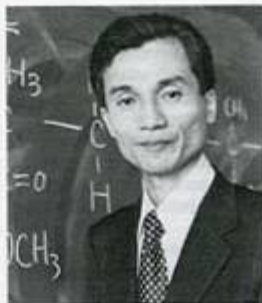
Kyoto and the favorable environment around MACRO 88 also was the basis of the first Council meeting of the recently



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formed Pacific Polymer Federation where the first meeting in Maui, December 12-15, 1989 was established. Polymer Summit, Kyoto, a meeting place of representatives, polymer organizations and societies from 23 countries and 3 regions as well as the "IUPAC Forum" was also held during the IUPAC 32nd Symposium on Macromolecules under the leadership of Professor T. Saegusa, the chairman of the Macromolecular Division of IUPAC. In the forum activities of the division were introduced by T. Saegusa, activities of the commission on macromolecular nomenclature by P. Kratochvil (Czech.), and activities of the commission on polymer characterization and properties by M. Mandel (Netherlands). Discussions on the future activities of the division followed the presentations.

The Conference started in the evening of Monday, August 1, 1988 with an opening reception given by the Society of Polymer Science, Japan which was a traditional Japanese reception featuring beer and Suntory Whiskey with a variety of food. The young polymer chemists of Japan invited the conference participants to a beer party on Tuesday evening. Both events were held at the Kyoto International Conference Hall. On Wednesday, the official banquet was held at the Kyoto Hotel; it was attended by over 500 participants.

A ladies program was arranged for the 63 accompanying guests from overseas which included visits to various historic monuments of Kyoto and also some of the interesting and traditional places of Kyoto. Various tours were also arranged in the surroundings of Kyoto.

The conference was opened by Professor Saegusa, the organizer of the symposium and chairman of IUPAC Macromolecular Division. The conferees were also greeted by Professor T. Higashimura, the President of the Society of Polymer Science, Japan and Professor W. Heitz, the Vice President of the IUPAC Macromolecular Division. Dr. J. Kondo, the President of the Science Council of Japan extended his address celebrating the opening of the Symposium. The address of the Mayor of Kyoto, M. Imagawa, was given by Mr. Y. Okuno, the Deputy Mayor of the city.

In his opening plenary lecture, Professor W. J. Bailey of the University of Maryland and former president of the American Chemical Society presented his work on "Radical polymerization of cyclic compounds" where he described the polymerization of 2-vinyldioxolanes and other cyclic compounds to biodegradable aliphatic polyesters. Some of them showed expansion of volume during the polymerization. The next plenary lecture was given by E. W. Fischer of the Federal



Professor T. Saegusa (left) and W. J. Bailey (right) enjoying the banquet.



Ladies learning how to put on a Japanese traditional dress, kimono, at Kimono Show.

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Republic of Germany on the "Structure of homopolymers, block polymers and polymer blends as revealed by neutron scattering." He presented a very excellent review of the now 15 year old new techniques to evaluate polymeric structures in solution and in the solid state. A most impressive lecture was given by Y. Ito chairman of the board of Toray Industries in Japan on the "Future prospects of polymer industry." He emphasized the fusion of polymer technologies with other advanced fields, which contributes to the pursuit of individual affluence and realization of healthy life for elder people.

The symposium's scientific activities were continued in lecture rooms of the Conference Hall by the presentation of invited lectures (45 min. each), session lectures (30 min.), oral communications (14 min.) and posters within the following 6 frameworks:

1. Polymerization chemistry
2. Synthesis of new polymers and polymer reactions
3. Structure and properties of polymers
4. High performance polymers
5. Functional polymers
6. Bio-related polymers.

In the first two sessions about 130 oral communications and about 50 posters were presented, demonstrating still growing activities in synthetic polymer chemistry.

Control of polymerization reaction permits us to control polymer structure. Along this way, living polymerizations via various processes have been developed in recent years. T. Higashimura (Japan) has established living cationic polymerization of vinyl ethers. The concept of "Stabilization of carbocation" by counterions or by additional weak bases was adopted for their living polymerization system. The wide scope of "Macromolecular design" via living carbocationic polymerization of isobutylene was emphasized by J. P. Kennedy (U.S.A.) in his invited lecture. Organosilicon chemistry was emerged in "Living cationic ring-opening polymerization" using a spiro-silane by D. Y. Sogah (U.S.A.).

S. Inoue (Japan) has proposed "Immortal polymerization" of epoxide with metalloporphyrin, where the polymer with controlled molecular weight was obtained in the presence of alcohol as transfer agent. Highly isotactic and syndiotactic living polymerizations were achieved on methacrylates through anionic mechanism using *t*-BuMgBr by K. Hatada (Japan), and *t*-BuLi-R₃Al by T. Kitayama (Japan), respectively.

T. Saegusa presented a session lecture "Functional polymers on the basis of 2-oxazolines," showing a wide variety of utilization including non-ionic surfactant. His group also developed a new process of ring-opening polymerization of vinylcyclopropanes by Pd(0) complex. Kinetic aspects of ring-opening polymerization were discussed by S. Penczek (Poland) and by H. Sekiguchi (France), focusing on "activated monomer mechanism." As for the coordination olefin polymerization by metal complex, the structural elucidation of active sites (K. Soga, Japan) and the development of new catalyst (H. Yanagihara, Japan, M. Kakugo, Japan) were reported. Metathesis polymerization of cyclic olefins was surveyed by H. Hoeker (F.R.G.) on ring-chain equilibrium and by K. J. Ivin (U.K.) on kinetics and rearrangement of tungstacyclobutane to tungsten-carbene monitored by ¹H NMR. Preparations of high cis polyacetylene via coordination polymerization were reported by H. Shirakawa (Japan) using "liquid crystal method" and by Z. Shen (China) using rare-earth metals. The rare-earth catalysts were also effective for

preparations of high cis poly(phenylacetylene) and epoxide polymers.

M. Kamachi (Japan) reported ESR observation of propagating radical of vinyl ethers, concluding the deviation from *sp*² planar conformation of the radical center. Unexpectedly high reactivity of bulky dialkyl fumarates was elucidated by B. Yamada (Japan) from the determination of kinetic parameters and ESR spin-trapping experiment. Alternating radical copolymerization of donor and acceptor monomers was discussed by V. P. Zubov (USSR). Formation of heterotactic alternating copolymer of styrene and methyl methacrylate was reported by Y. Gotoh (Japan). D. J. T. Hill demonstrated the validity of penultimate model of the copolymerization of styrene and acrylonitrile up to 90% conversion. J. C. Salamone (U.S.A.) reported, in his session lecture "Cationic/anionic monomers and polymers," the formation of alternating ampholytic copolymers by a charge transfer polymerization process, and demonstrated gel formation of an aqueous solution of the polymer under shear or simply by shaking it.

Stereochemistry of macromolecular chains were discussed by M. Farina (Italy) from a fundamental point of view, and by P. Pino (Switzerland) focusing on regio- and stereospecificity of chiral Ziegler-Natta catalysts. O. Vogl (U.S.A.) mentioned a method for the measurement of optical rotation in suspension, which provides a tool for characterizing rigid helical polymers. Asymmetric polymerization mechanism of methacrylates giving helical polymers and their utilization to chromatographic separation of racemates were presented by Y. Okamoto (Japan).

A session lecture by R. Chūjō (Japan), "NMR characterization of amorphous piezoelectric polymers" showed dominant importance of NMR spectroscopy in polymer characterization. Two-dimensional NMR and solid-state high resolution NMR become more and more familiar to polymer scientists as evidenced by so many papers presented at this conference. Among the NMR accessible nuclei, deuterium NMR was proved by E. T. Samulski (U.S.A.) to be effective in the studies of ordered structure and specific motions in polymer chains. "Dynamic-infrared linear dichroism and two-dimensional infrared analysis of polymers" reported by I. Noda



Professor J. C. Salamone showing the gelation of his polymer.

(U.S.A.) showed new possibility of IR spectroscopy for the detection of specific interaction and connectivity among functional groups. Scanning tunneling microscopy was also newly introduced to micro-characterization of polymers on metal surfaces by T. Nishi (Japan).

As demonstrated by about 60 oral presentations and about 80 posters in the high performance polymers, the synthesis of new chemical structure of polymer or the processing of the conventional plastics for high modulus and high strength polymers is very attractive for polymer scientists. In this section recent developments in high temperature polymers, high modulus and high strength polymers, polymer liquid crystals, polymer alloys and polymer composites, elastomers and new polymer processing were presented. H. Cherdron (F.R.G.) surveyed in his invited lecture "New high performance polymers," the general overview and development of high performance polymers, e.g., polyaryles, polyether ketones, polybenzimidazole, fluorinated polyamides and graphited polymers. The invited lecture of T. D. Goldman (U.S.A.) "Thermoplastic glutarimide polymer" was focused on the polymer characterization and reaction mechanism with an alkylating agent. Studies on the high temperature polymers were reported from various research groups for polyamic acid, epoxide, fluoro polymers, polyheteroarylene, poly(amine-sulfone) and poly(amine-ketone). The polymer modification for application of composite materials was given by M. Takayanagi (Japan) in his invited lecture "Modification of wholly aromatic polyamides for high performance materials," using sodium methylsulfinyl carbanion which reacts with poly(p-phenylene terephthalamide) (PPTA) to give a homogeneous solution of PPTA polyanion in DMSO.

New and low cost thermotropic liquid crystalline polymers were reported by W. J. Jackson, Jr. (U.S.A.) in his invited lecture "New high performance plastics of liquid

crystalline polyesters (LCP)" concerning about the thermal, rheological and molding plastic properties of LCP's prepared from dimethyl trans-4,4'-stilbenedicarboxylate and aliphatic glycol. Wholly aromatic polyester (Ekonol type) was described by H. Sugimoto (Japan) in his session lecture. He has tried to produce many copolyesters composed of p-hydroxy benzoic acid, aromatic dicarboxylic acids and aromatic diphenols to improve the processability of LCP. J. P. Quentin (France), X. Y. Wang (China), and H.-J. Park (Korea) presented the LCP behaviors of new aromatic polyesters and copolyesters.

On the other hand, many attempts to obtain high modulus and high-strength fiber for the conventional flexible polymers, e.g., ultrahigh molecular weight polyethylene (UHMWPE), poly(vinyl alcohol) (PVA), poly(ethylene terephthalate) (PET), and polyacrylonitrile (PAN) were presented. UHMWPE has been commercialized as a high-strength fiber in Japan, U.S.A. and European countries. The invited lecture of A. J. Pennings (Netherlands) "Structure development in high-strength polyethylene fibers" summarized the preparation and properties of high-strength polyethylene fiber. The high-modulus and high-strength UHMWPE was prepared by the melt-draw orientation method (Y. Akana, Japan), by super-drawing of UHMWPE reactor powder (T. Kanamoto, Japan), by biaxial drawing of dried gel fiber of UHMWPE (Y. Sakai, Japan), by elongation of UHMWPE gels (K. Koyama, Japan), and by PE fiber-reinforced composite (N. A. J. M. van Aerle, Netherlands). The other approaches for flexible polymer to gain the high-modulus and high-strength were carried out by P. Tucker (U.S.A.) on high-speed spinning and characterization of spun PET fibers, by T. Kunugi (Japan) on PVA fibers by the zone-annealing method, and by W. Sweeny (U.S.A.) on the preparation extended chain of PAN.



Poster Session

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About 100 oral communications and 80 posters were presented on functional polymers including polymers for optics and optoelectrics, for photo- and radiation-sensitive polymers, for electroactive polymers, for thin films, and for membranes and separation. The attention by participants on this section focused mainly on the conducting polymers, organic ferromagnetic polymers and non-linear optical (NLO) polymers. H. Shirakawa (Japan) discussed the high alignment of fibril morphology in cis-rich polyacetylene (PA) formed films in low-temperature nematic liquid crystal. PA-iodine doping yielded a maximum conducting of 1.6×10^4 S/cm and electrical anisotropy of 6.9. M. Hirooka (Japan) discussed recent developments of polyarylenevinyls through precursor processes with improvements of stretching technique in his invited lecture "Highly conducting polymers via soluble precursors." The polymer gave the conductivity of 1.1×10^4 S/cm. In his invited lecture "Molecular design of conjugated polymers for electrical and optical properties" G. Wegner (F.R.G.) presented the preparation and physical properties of various conducting polymers. Poly(diacetylene), poly(alkylthiophene), poly(alkylpyrrole), polyalkoxy substituted polyphthalocyaninosiloxanes and alkyl-substituted polyarene are representative of present aspects of the conducting polymers. F. Garnier (France) in his session lecture "Organic semiconducting polymers for electronic devices" discussed the field-effect type microelectrochemical transition and the semiconducting characteristics of polythiophene and its 3-substituted derivatives. Polymeric organic ferromagnet material was presented by the invited lecture of A. A. Ovchinnikov (USSR). He presented the two types of ferromagnetic polymers. One ferromagnetic polymer was obtained by the polymerization of an acetylene with a nitroxyl radical substituent, and the other one was prepared by pyrolytic decomposition of PAN. T. Sugano (Japan) has reexamined the polymerization of acetylene with a nitroxyl radical substituent, and the USSR group's ferromagnetic behavior. The existence of truly organic ferromagnetic polymer was still obscure.

A tremendous interest in the electroactive properties of organic and polymeric materials grows the designed molecular architecture of new electronic and optical materials. S. K. Tripathy (U.S.A.) gave his invited lecture on molecular design of organic and polymeric materials for NLO. Polydiacetylene monolayers with appropriate side groups organized by the Langmuir-Blodgett (LB) technique may demonstrate a unique combination of cubic and quadratic NLO properties and their respective modulation. Preparation of novel polydiacetylenes by topochemical solid state polymerization and their NLO properties were described by H. Nakanishi in his session lecture. Another approach to obtain NLO polymers was reviewed by C. Noel (France) in her session lecture of LCP. Ferroelectric polymers were also

interesting from the aspects of their application; poly(vinylidene fluoride) and their copolymers by A. J. Lovinger (U.S.A.), LC ferroelectric polymers by V. P. Shibaev (USSR). J. Pfeifer (Switzerland) reported the application of high-performance polymers to the photosensitive polymers in his session lecture "Photosensitive polyimide resins." M. Irie (Japan) prepared photoresponsive polymers using the rod-shaped acrylamide gels. The gels showed reversible bending upon ultraviolet irradiation in an electric field. The preparations of thin-film using various methods including plasma and electrochemical polymerization and LB-technique were reported from several groups. Y. Imai (Japan) has developed a novel method to prepare mono- and multilayer films of polyimides through LB technique. N. Ogata (Japan) has succeeded in the synthesis of aromatic condensation polymers, poly(1,4-phenylene-5,5'(6,6'-bibenzoxazole-2,2'-diyl)) from monomers spread at the air/water interface and in the preparation of their built-up film.

A session of Bio-related Polymers was organized to include "Natural Polymers and Their Modification," "Polymers of Biological Interest," and "Polymers of Medical Interest." I. Tinoco, Jr. (U.S.A.) showed sophisticated application of 2D NMR spectroscopy to the structural elucidation of DNA and RNA in his invited lecture, "Nucleic acid structures from A to Z." "Local helix-coil transition in DNA" or the stability of the double helix was discussed by A. Wada (Japan) with emphasis on its genetic implication. Understanding of the interaction between polymeric materials and living organs is essential in the biomedical use of polymers. Discussion on this subject was made by P. Ferruti (Italy) and N. A. Platé (USSR) on de-heparinization, and by H. B. Lee (Korea) on implantable devices. Artificial membranes and its biomimetic functions were discussed by T. Kunitake (Japan) and R. Schwyzer (Switzerland). Kunitake demonstrated that synthetic chiral bilayer membranes grew to helical superstructure. Schwyzer found new modes of specific interactions of flexible, water-soluble neuropeptides with artificial lipid membranes, and proposed "Membrane compartments theory" to describe the molecular mechanism of receptor selection. Activities shown in this session impressed on many participants the importance of the fusion of biochemistry and polymer science.

The conference was concluded with the closing ceremony followed by another traditional beer party at the Conference Hall on Saturday noon. "IUPAC Macromolecules Kyoto," the proceedings of this symposium, which contains the full papers of plenary, invited and session lectures, will be published at the end of March, 1989 by Blackwell Scientific Publications, Ltd., as announced in the closing ceremony. The next "MACRO" will be organized from July 8 to 13, 1990 in Montreal, as announced by Professor R. E. Prud'homme in an address of invitation during the closing ceremony.