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Polymer Science in the South and West of Japan

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In previous articles on research activities in polymer science and engineering, the Central part of Japan, located on Honshu, the main island of Japan, has been discussed. This is the area of the highest concentration of population, industrialization and higher education. As a consequence, a substantial part of teaching and research in polymer science and engineering is concentrated in this part which consists of the greater Tokyo area (Kanto District), the Osaka, Kyoto area (Kansai District) and the Nagoya area (Tokai District). In this article, polymer science and engineering at universities of the western Honshu (Chugoku District), and the districts of the Islands of Kyushu and Shikoku will be described. In this region a number of institutions were created after the second world war when the new university system was established in 1949 based on the National School Establishment Law.



THE KYUSHU DISTRICTS

Since its establishment in 1911, Kyushu University, a major national university, has had most disciplines of science and engineering represented in its education structure. A number of national universities and private universities were established in Kyushu after the war. Polymer research in universities in the Kyushu Districts is being carried out in research groups in various departments of the faculty of engineering although there are a few polymer-related research groups in science faculties.

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Jitsuo Kiji



Toyoki Kunitake

KYUSHU UNIVERSITY, FUKUOKA

Faculty of Engineering

Professor Motowo Takayanagi has been investigating physical properties of the solid state of polymeric mate-



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rials by characterizing their superstructure. The present direction of his research is attempting to create a new combination of physical properties of rigid molecules of the aramide polymer type especially those with increased compatibility with the conventional polymers and then show increased modulus and thermal stability. Further evaluation of the spinning of these polymers in the liquid crystal state led to the formation of multifilaments with greater strength in compression. Associate Professor Tisato Kajiyama is studying permeability changes caused by phase transitions in composite membrane of liquid crystal materials and polymers. He is also developing new membrane materials with liquid crystalline properties. In collaboration with Prof. Takayanagi, Instructor Kenji Yamada is studying poly(α -olefins) with ultra-high modulus and the influence of molecular orientation of poly(vinylidene fluoride) on piezoelectricity. Instructor Kenji Okuyama is evaluating the helical structure of the collagen molecule based on the precise x-ray diffraction of model peptides.

Professor Tetsuo Takemura who founded the high-pressure physics laboratory at Kyushu University some ten years ago, is still designing novel high-pressure apparatuses for such applications as differential thermal analysis, dilatometry and NMR spectroscopy, instruments for rapid measurements of ultrasonic velocity and attenuation, for light scattering, Raman scattering, and Brillouin scattering, and x-ray systems. These new instruments are useful for the investigation of pressure-sensitive materials (liquid crystals and polymers) under high pressure. With Instructor Kazumi Matsushige, he is studying piezoelectricity and ferroelectricity of poly(vinylidene fluoride) under high pressure.

Professor Tomoo Oyama has perfected the parameter theory for polymer solutions and with Yoshitsugu Oono is working on the renormalization theory. By considering the 3rd virial coefficient, Professor Oyama and Instructor Kohzoh Shiokawa found a simple derivation of a T-C diagram identical with that derived from the scaling theory. They designed a new light scattering photometer, and can now measure radius of gyration (\bar{r}^2) as small as 5 nm; they also recognized the dependence of (\bar{r}^2) on molecular weight and temperature below the theta-region. Associate Professor Kanichiro Takamizawa and Instructor Yoshiko Urabe designed a quantitative high pressure differential thermal analysis apparatus and can now examine the phase transition of the extended chain crystal (ECC) of polyethylene and other polymers under high pressure. The molecular weight dependence of the phase transition and the crystallization mechanism of long chain n-alkanes is also being studied.

Professor Yasuhiro Murakami is evaluating bulk polymerization processes and the aftertreatment of polymers. He is examining reactions in motion (vertical and horizontal) and static reactions (tower type and static mixer). Reactions in motion have a wide range of viscosity characteristics from a surface renewal reactor (10^1 - 10^4 poises) to a gas phase bulk reactor (10^{-3} - 10^{-4} poises); some configurations show substantial energy savings of up to 90% for mixing equipment for highly viscous liquids. Instructor Tsutomu Hirose is working on the spherical agglomeration problem in the thin film reactor, for the purpose of eliminating the pelletizing process.

Instructor Masaharu Takao is investigating the relationship between mixing performance and reaction progress using the Damkohler number, and is also interested in the development of gas phase bulk polymerization reactors.

Professor Toyoki Kunitake is investigating vinyl polymerizations and polymeric catalysts, and most recently, synthetic bilayer membranes. In the field of vinyl polymerization, he is studying the steric course of the radical cyclopropagation and the steric course of the radical cyclopolymerization of divinyl monomers by ^{13}C NMR spectroscopy. In cooperation with Professor Shinkai now at Nagasaki University and Assistant Professor Yoshio Okahata, Professor Kunitake developed enzyme model polymers which catalyzed the hydrolysis of esters at substantially enhanced rates. With Instructors Naotoshi Nakashima and Masatsugu Shimomura, the development of synthetic bilayer membranes is being investigated.

Graduate School of Engineering Sciences

Professor Shogo Saito with Associate Professor Ryuichi Tanaka and Instructor Tetsuo Tsutsui, is trying to develop new possibilities for the use of polymeric materials in electronics. One of the projects is aimed at the design of organic conductors and semiconductors. For several thermally stable polymers the mechanisms of the photo-carrier generation and the carrier transport are being investigated. The second project involves the development of new optical devices, for example, cholesteric films which selectively reflect visible light. Optical data storage materials using organic photochromic substances are also being studied. Dr. Tanaka is also working on the synthesis of linear and crosslinked polymeric amines and the applications of these polymers for organic synthesis and separation techniques.

Faculty of Science

Professor Ryohei Matsuura and Associate Professor Kinsai Motomura are studying the interfacial behavior of polymers. Some polar polymers such as poly(alkyl methacrylate) were found to form monomolecular films on water which possess physicochemical and mechanical characteristics different from those of fatty acid monolayers and poly(octadecyl methacrylate) monolayers crystallize by a linear growth mechanism. The adsorption behavior of polymers onto the oil/water interface on the basis of all the thermodynamic quantities of adsorption is also being investigated.

KYUSHU SANGYO UNIVERSITY, FUKUOKA

Department of Industrial Chemistry: Professor Shunichi Yoshinaga, Associate Professor Toshiyuki Nagaishi and Instructor Masaru Matsumoto are in-

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ignating the decrease of the flammability of poly(vinyl chloride) by addition of inorganic salts and by removal of hydrogen chloride.

Department of Photography: Professor Akihiro Kinoshita, Instructors Ikuro Naito and Yoichi Namariyama have a cooperative program for the study of nonsilver photography based on various vinyl ketone polymers and are studying the mechanism of the Norrish type photodegradation reaction. Laser flash techniques are used to follow the early state of degradation.

SAGA UNIVERSITY, SAGA

Department of Industrial Chemistry: Associate Professor Kazuaki Suehiro is conducting research on the chain conformation and the solid state structure of polymers, in particular, x-ray diffraction of polymer crystals with packing disorder. The change in the crystal structure due to the introduction of comonomers in the polymer structure and the conformation in the chain folds of poly(ethylene terephthalate) single crystals are also being studied.

KUMAMOTO UNIVERSITY, KUMAMOTO

Faculty of Engineering

Professor Yoshiaki Motozato, in cooperation with Associate Professor Chuichi Hirayama is developing new gel matrices for high-speed gel permeation chromatography and affinity chromatography. The gel matrix may be homogeneous, heterogeneous or of peculiar bilayer structure. The gel prepared from cellulose and poly(vinyl alcohol) was shown to efficiently separate water-soluble polymers.

The research group led by Professor Hiroaki Egawa and Assistant Professor Takamasa Nonaka is interested in the exploration of new functional polymers. They include: (1) Synthesis of chelating resins and their applications to recovery of precious metals including uranium, (2) preparation and use of water-soluble, cationic polymers, (3) photosensitive polymers with episulfide side chains, and (4) development of new monomers for the synthesis of new functional polymers.

Professor Naoshi Kusumoto, with Instructor Kumiko Tomoeda, is investigating the molecular motion of synthetic and natural polymers by the spin label or spin probe technique. They are also studying the reaction of spin traps with polymer radicals as a function of the motion of polymer chains. Other subjects include studies of the spin probe of synthetic bilayer membranes and of the γ -ray irradiation effect on oriented polymer films.

School of General Education

Professor Shizuo Arichi, Associate Professor Noriyuki Sakamoto and Instructor Masafumi Yoshida are interested in solution properties of polymers. For poly(2-vinyl-

pyridine), poly(2-vinylpyridine-N-oxide), poly(4-acetoxy-styrene), head-to-head polypropylene, the polymer structure in dilute solution and the thermodynamic interaction of polymer molecules in solution is being studied.

NAGASAKI UNIVERSITY, NAGASAKI

Faculty of Engineering

The research activities of Professor Tetsuo Yokoyama fall into three categories: (1) Establishment of the influence of the network structure of polyurethane on its physical properties (with Instructor Matsuhisa Furukawa), (2) elucidation of the effect of ionic forces on the solid state property of ionic polymers, and (3) introduction of nucleic acid bases into polyurethanes or polysaccharides. They found that polyacrylate salts with larger cations have greater water uptake in the solid state, and also worked toward a better understanding of the crosslinks in polyurethane structures by amine degradation techniques.

Associate Professor Seiji Shinkai is interested in functional polymers and polymer catalysts. Redox reaction of such coenzymes as flavins and NADH are catalyzed by polymer micelles which also are beneficial for nucleophilic displacement and decarboxylation reactions. Other areas of investigation are the photochemical reaction of the azobenzene moiety, the selectivity of ion extraction of crown ether complexed ions and the rate of ion transport through liquid membranes which can be photochemically controlled.

Faculty of Pharmaceutical Sciences

Professor Kazuo Kawahara with Instructor Kazuko Ohta is studying the solution and sedimentation properties of polysaccharides for their use as plasma extenders. The identification of excreted dextran fractions gives quantitative information on the permeation of dextrans through the human kidney and how dextran degrades. Modified dextrans, pullulan and hydroxyethyl starch are also being examined.

MIYAZAKI UNIVERSITY, MIYAZAKI

Faculty of Engineering

Professor Kiyohisa Imada is working on various aspects of polysaccharide chemistry.

THE CHUGOKU AND SHIKOKU DISTRICTS

All universities in the Chugoku (western Honshu) and Shikoku Districts were created in 1949 in accordance with the National School Establishment Law.