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Personalities in Polymer Science



Makoto Okawara

Makoto Okawara played a significant role in organic and polymer chemistry in post-war Japan. He pioneered the field "reactions on polymers" and the use of polymer supports in many applications. At the Tokyo Institute of Technology he was substantially responsible for the development of the **Research Laboratory of Resources Utilization**. The motto of his scientific life is stated on his name card: **Chemistry – study it, use it and enjoy it.**

Makoto Okawara was born on September 11, 1923 in Shanghai as the son of Yukichi Okawara, a native of Fukushima and Take Okawara, née Mito. His father was involved and an expert in shipping and his family moved frequently.

Makoto went to primary school in several port cities, because of his father's profession including Hiroshima, Nagasaki, Kobe and Yokohama. He ultimately graduated from the Yokohama Dai-ichi Middle School, which in the old Japanese system corresponds now to the Junior and Senior High School. He then went to Okayama, in the Western part of Japan. He studied in the Sixth High School, which would correspond today to a liberal arts college. He graduated in 1942, three years after Professor Teiji Tsuruta (*Polymer News*, 20(9), 275 (1995)) had graduated from the same High School.

In September 1942 Makoto Okawara enrolled in the Tokyo Institute of Technology, studied Applied Chemistry

in the Faculty of Engineering and graduated with a B.E. degree in 1945. What he learned about polymer chemistry were in lessons of organic chemistry. In 1943 he had attended lectures on organic chemistry, especially the Reppe reaction of acetylene from Professor Toshio Hoshino, one of the pioneers of organic chemistry in Japan. The first chemist that analyzed the materials of American parachute material (Nylon) and synthesized the nylon from adipic acid and hexamethylene diamine was also Professor Hoshino.

After graduating from the Tokyo Institute of Technology (TIT) in 1945, he left the burned-out city of Tokyo and started to teach students (17–19 years old) at the Higher Technical School (Ube College) at Ube City, Yamaguchi prefecture in the South West of the Main Island of Japan, Hondo. He started to carry out his own private experiments, from the synthesis of the artificial sweetener, Saccharin, to fast and effective sleeping drugs.

During the reform of the education system in Japan in the late 1940's Ube College became Yamaguchi University. And in 1951 Okawara became Associate Professor (Jo-Kyoju) at Yamaguchi University.

In 1954, Makoto Okawara accepted a position at the Osaka Prefecture University in Sakai City, Osaka Prefecture. After these beginnings in teaching and science, he studied organic chemistry under Professor Eiji Imoto at the University of Osaka Prefecture, a continuation of his early academic and scientific interests. Initially he was concerned with radical reactions in solutions and stabilized carbenium ions; he later became involved with the chemistry of organic sulfur- and tin compounds and of organic photochemistry.

Makoto Okawara also started to attend lectures and discussions, presented by Professor Minoru Imoto (University of Osaka City) and his brother Eiji Imoto in polymer chemistry. He also started reading books on polymer chemistry: "Discovery of Nylon" by M. Imoto and "Silica and Me" by B. Alexander of Du Pont and became more and more interested in polymer science.

During this period at the University of Osaka Prefecture, Okawara worked toward his Ph.D. under the direction of Professor Eiji Imoto. He received his

degree in 1956 with a thesis entitled "Free Radical Reactions in Solution". After receiving his degree, he had the opportunity to go abroad and spent one year from 1955–56 in the United States at Ohio State University where he worked with Professor Melvin S. Newman on the "Study of [14]Helicene".

Polymer science became independent from chemistry in Japan around 1960 and Makoto Okawara switched his scientific interests to polymer chemistry. Since building up the laboratory at TIT, his dream and interest in polymer science had increased and he began studying chemical reactions on polymers and the design of functional polymers. He "selected" polymers as substrates to carry out, on them, organic chemistry. In his concept and research strategy he divided the functions into the dynamic (D-, including chemical and physical functions), static (S-, physical properties) and shaping (Sh-, fiber, particle, surface etc). He thereby classified and evaluated various kinds of materials and functions and proposed the design of new functional polymers by combining these D-, S-, and Sh- functions.

In 1965 he was offered and accepted the position of Professor (Kyoju) at the Tokyo Institute of Technology, at the Research Laboratory of Resources Utilization. During his tenure at TIT, he also served three years as the Dean of the Research Laboratory of Resources Utilization. After 19 years of exceptional service, he retired and became Professor Emeritus in 1984.

His studies in polymer science started with his interest in "polymer reactions". They were based on the organic chemistry mentioned above using commercial polymers as starting materials. For example he used polystyrene as the polymeric form of benzene and toluene, poly(vinyl alcohol) or as the polymeric form of alcohols and poly(vinyl chloride) of alkyl halides. The special techniques that was needed to work up reaction products of such polymers, the subtle change in the reaction mechanism on a macromolecular substrates was also investigated in his laboratory. Of particular interest were solvent effects and special features of polymer reactions in homogeneous media.

During this period numerous polymeric derivatives were synthesized by derivation of new materials with high additional value. These "functional

polymers" included chemically reactive polymers, ion exchangers, chelating polymers, redox polymers, photosensitive and electroconductive polymers, polymeric dyes and catalysts. Polymers were also produced that support chemical reactions (polymer reagents) or were carriers for drugs and polymers with slow release capability.

After Okawara formally retired, he became interested in applying these basic principles developed in his research activities to practical problems particularly the design of reactive monomers and polymers, surface reactions and organic-inorganic hybrid materials. After he had retired from TIT at the age of 60 years, he maintained a private office and continued his consulting work which placed him between academia and industry.

Over these years his interests spread over a wider area and included inorganic chemistry, e.g. modification of glass surfaces, sol-gel reactions involving metal oxides and also the correlation between polymer structure and physical (mechanical) properties, from the view point of practical use of materials. Hybridization of organic and polymer chemistry and of small molecules and macromolecules, have been of the same importance as the recently advanced hybridization of organic and inorganic materials.

Makoto Okawara's scientific work was published in 270 scientific papers, 65 review articles, 5 books and 20 book chapters. His work was also recognized by several awards. In 1974, he received the Award of the Society of Synthetic Organic Chemistry and in 1985 of the Society of Polymer Science, Japan. In the years of 1985-86 he served as the Vice President of the Chemical Society of Japan. He was also active as consultant for several companies.

In his youth Makoto was an enthusiastic baseball player, an excellent pitcher and a highly regarded Judo wrestler. Among his achievement is that he is the holder of the black belt of the forth grade, a very high rank in Judo wrestling. Now he spends much time reading, particularly novels.

In 1949, Makoto Okawara married Kō Sato. They have two married children and four grandchildren. The husband of one of his daughters is Professor Masa-Aki Kakimoto, who is Professor in Polymer Chemistry at the Tokyo Institute of Technology.

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