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Obituary

Baotong Huang – Obituaries

Professor Baotong Huang (1921–2005)

On September 6, 2005, Professor Baotong Huang, who was a famous polymer chemist, passed away after a sudden myocardial infarction in Changchun, China.

Professor Baotong Huang (formerly known as Pao-tung Huang) was born on May 1st, 1921 in Shanghai, China. He enrolled as a chemistry major at the University of Hujiang in 1940. As a result of Pacific War, he was transferred to the National Central University in Chongqing in 1942 where he finished his Bachelor's degree in chemistry in 1944. He went to the United States to pursue his graduate education in 1947. Next year he earned his Masters of Science in chemistry, under Professor Ralph T. Holman at the Texas A & M University; and then, he received his Ph.D. degree at the Polytechnic Institute of Brooklyn (currently known as Polytechnic University) along with Professor Charles G. Overberger in 1952 with a major in organic chemistry and ancillary in polymer chemistry. He was bestowed with memberships of Sigma Xi and Phi Lambda Epsilon. He then held a position as a Research Associate at the Plastics Laboratory of Princeton University for two and half years. In 1955, he returned to China and became a staff member of the Changchun Institute of Applied Chemistry (CIAC), Chinese Academy of Sciences, where he taught and worked until the last minute of his life. While at the CIAC, Professor Huang served as an Associate Professor, Full Professor, Director of Polymer Chemistry Laboratory, Head of the CIAC Graduate School, and Deputy Director of CIAC (1980–1984). Professor Huang had been an academician of the Chinese Academy of Sciences since 1991. He had been a Member of the Standing Committee of the Chinese Chemical Society, a Member of the Polymer Division of CCS, a former Chairman and a Member of the Applied Chemistry Division of CCS, and former Chairman of the Provincial and Changchun Chemical Societies. He was on the editorial board of "Chinese Journal of Polymer Science", "Acta Polymerica Sinica", and "Chinese Science Bulletin" and on the Advisory Board of "Journal of Polymer Science, Polym. Chem. Ed." (1980–1989). He had been the Chief Editor of "Chinese Journal of Applied Chemistry". Also he was an honorary Professor of Northeastern University and Adjunct Professor of five other universities, and a Deputy to the National People's Congress (non-partisan, 1983–1998).

Among his 230 publications, Professor Huang contributed 180 papers in the areas of olefin polymerization by Ziegler–Natta/metallocene catalysts, polymer blends, and polymer compatibilization. He was the primary author of "Synthetic Rubbers by Coordination Polymerization" (1983) and "Advances in Coordination Polymerization of Olefins and Dienes" (1998). Professor Huang was invited to coauthor books "English–Chinese and Chinese–English Vocabulary on Polymers" (1996) and "Metallocenes and their Catalysts in Polymerization of Olefins" (2000). He translated numerous technical articles and books from English to Chinese; one example was "Late Transition Metal Polymerization Catalysis" (Edited by B. Rieger et al.) (2005). In addition, Professor Huang made significant contribution in the application of polymer technology. He applied 16 Chinese patents and one US patent. As a holder of the first Chinese patent on polypropylene/EPDM thermoplastic vulcanizate, he and his coworkers transformed this technology into industrial application. He had been the advisor for 45 Master, Doctorate, and Post-Doctorate students in the past 30 years.

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The early work of Professor Huang in USA was on organic chemistry, especially the synthesis of novel cyclic hydrazines from diketones, and then he proposed a new decomposition mechanism [1] when he was a Ph.D. candidate at the Polytechnic Institute of Brooklyn. At the Changchun Institute of Applied Chemistry, Professor Huang began his research in the areas of Chinese lacquer and hydrocarbon autooxidation. In his pioneering work the drying mechanism was better understood as a combined process of the laccase oxidation of the catechol ring and the autooxidation of the double bonds on the side-chain. Among his earlier researches in ethylene–propylene copolymerization, his discovery of the new catalysts was granted the first academic award by Chinese Academy of Sciences in 1980.

Since 1979, his research interests concentrated on compatibilization of the blends of polyolefin/polar polymer and coordination polymerization of olefins by Ziegler–Natta and Kaminsky (metallocene) catalysts; the former won second prize of the Academy's Natural Sciences Award of 2000 and a summary of which was presented as a plenary lecture at the 2nd East Asian Polymer Conference. During compatibilization of immiscible binary blends, especially the blends in which one of components was polyolefins, he believed that researches on polyolefin/polar polymer blends could provide a large space to create novel materials and improve the properties of common polymers. As a polymer chemist, he realized that some approaches for synthesizing block or graft copolymers were necessary to improve interfacial compatibility between two components in the polymer blends. The body of the work reported by the group of Professor Huang contributed to the compatibilization of polyolefins/polar polymer blends. In the course of the work, however, some blends besides polyolefin/polar polymer pairs had also been explored. Together they contributed towards the understanding of the structures and factors affecting compatibilization.

He made a series of investigations on miscibility of commercially available polyethylene (PE) blends due to their different chain structures as a result of different polymerization mechanisms or their chain compositions, such as low density PE (LDPE), high density PE (HDPE), linear low density PE (LLDPE) and very low density PE (VLDPE). It is worthwhile to mention that variation in the size of the interphase (mesophase) between crystalline and non-crystalline phases in the blends of the PEs was studied by Raman spectroscopy, whereby a chopstick model for the variation among the three phases (crystalline, amorphous and meso) with blend composition was advanced by Professor Huang and his coworkers for rational explanation [2]. Professor Huang also used fluorescence technique to investigate miscibilities of LLDPE/HDPE and LLDPE/EMA (EMA: random copolymer of ethylene and methacrylic acid) [3]. His fluorescence studies offer an opportunity in understanding the much neglected aspects of penetration and entanglement in polyolefin blends.

In the past 20 years, Professor Baotong Huang had been one of the leading scientists in the compatibilization of polymer blends. He investigated microstructure and properties of 30 polymer blends with different compositions and different compatibilizers. The used compatibilizers included the following: (1) graft-type copolymers from functionalized polyolefins [4], macromer synthesis [5,6] and free radical grafting [7]; (2) block-type copolymers from anionic sequential polymerization [8–10], mechanism transformation [11,12] and sequential polymerization of olefins [13–15]; (3) ''Thread-through'' copolymers [16,17]; (4) random PE copolymers [18]. On the basis of these researches, Professor Huang and his coworker established the relations of the concentration of compatibilizer with interfacial tension and the size of dispersed phase [19]:

$$\gamma = (\gamma_O - \gamma_S)e^{-KC} + \gamma_S \quad (1)$$

$$R = (R_O - R_S)e^{-KC} + R_S \quad (2)$$

Up to now, many experimental results have shown the correctness of the above equations in compatibilized polymer blend (for example, Anastasiadis (1989) and Wolf (1997)). Thus the equations were repeatedly cited by the polymer scientists. In addition, Professor Huang had explored the effect of micelle formation of block-type compatibilizers on compatibilization of polymer blends [8] and the relationship of crystallization behaviour of polyolefin/polar polymer blends on compatibilization [20,21]. All of the results have played an important role in controlling the microstructure and properties of polymer blends.

In coordination polymerization of olefins by Ziegler–Natta and Kaminsky (metallocene) catalysts, Professor Huang focused on the preparation of high activity $MgCl_2$-supported Ziegler–Natta catalyst for copolymerization of ethylene/α-olefin and propylene/α-olefin and microstructure characterization of copolymers in the first half of 1980s [22]. He found that the addition of SiO_2 to the $MgCl_2$-supported titanium catalysts resulted in higher catalyst efficiency and higher comonomer incorporation when applied to ethylene/1-butene and ethylene/1-hexene copolymerizations. Furthermore, he and his coworkers advanced unsteady diffusion kinetic model of heterogeneous Ziegler–Natta catalyst polymerization [23]. With this kinetic model, many ''anomalous'' phenomena, such as the increase in catalyst efficiency in copolymerization with an α-olefin over that of ethylene homopolymerization and the accelerating effect of a lower α-olefin in the copolymerization of ethylene/higher α-olefin, were attributable to the unsteady diffusion of monomers [24]. With the view on the promoting effect of a lower α-olefin on ethylene/higher α-olefin copolymerization [23], it was predicted that a small amount of ethylene should remarkably enhance the copolymerizability of 1-hexadecene with propylene.

In the early 1990s, triggered by the Kaminsky's discovery of metallocene/MAO catalyst for olefin polymerization, Professor Huang conducted a series of works in this field. He synthesized new metallocene complexes to study the stereochemical control in propylene polymerization and found the influence of polymerization temperatures on enantiomorphic-site control and chain-end control, or an atactic polypropylene controlled by Bernoullian propagation mechanism [25,26].

The above result was the first example of this kind in the area of α-olefin stereochemical polymerization. In order to apply the homogeneous metallocene catalysts in the practical industrial production and the reduction of the use of expensive MAO as well, Professor Huang and his colleagues carried out much pioneering studies on supported metallocene catalyst with various supports, such as polymers [27], mesoporous materials [28], functionalized montmorillonite [29] and inorganic/organic core–shell particles [30]. Several patents were held in supported metallocene catalysts for ethylene polymerization.

Professor Baotong Huang was a devoted researcher, educator, mentor, and administrator in the field of polymer science. His major scientific contributions were in the areas of olefin polymerizations/catalysis, polymer blends and polymer compatibilization. His fine work has also been recognized internationally by his colleagues in the scientific field. Professor Huang also inspired numerous students and coworkers in the scientific discipline. As his former students, all of us learned scientific spirit from him, which guides all our lives and encourages us to devote to scientific research. Both his charismatic personality and his indelible contribution in polymer science will long live in the heart of his students and his friends. To most of us, Professor Baotong Huang will be remembered as an outstanding scientist; he will also be missed considerably as a kind gentleman, a tireless mentor, and a beloved friend.

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Wenqi Chen
Xuequan Zhang
Laboratory of Polymer Engineering
Changchun Institute of Applied Chemistry
Chinese Academy of Sciences
Changchun 130022, PR China

Jingjing Ma
Industrial Adhesive & Tape Division
3M Company
St. Paul, MN, USA

Tao Tang*
State Key Laboratory of Polymer Physics and Chemistry
Changchun Institute of Applied Chemistry
Chinese Academy of Sciences
Changchun 130022, PR China
*Corresponding author. Tel.: +86 431 85262004;
fax: +86 431 85262827.
E-mail address: ttang@ciac.jl.cn

Lin Li
State Key Laboratory of Polymer Physics and Chemistry
Institute of Chemistry
Chinese Academy of Sciences
Beijing 100080, PR China

Shengsheng Liu
Philip Morris USA Research Center
4201 Commerce Road
Richmond, VA 23234, USA

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