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POLYMER SCIENCE IN VIETNAM†

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INTRODUCTION

Vietnam is a country of about 330,000 square kilometers (128,000 square miles) and has more than 70 million inhabitants. It is divided into 39 provinces. Vietnam borders China to the North and Laos and Cambodia to the West. Hanoi, now a city of 2 million people, has been the capital of Vietnam for nearly a thousand years. The old name of Hanoi, Thang Long or “Flying Dragon,” is associated with the long-standing cultural and educational tradition of the city. The last royal dynasty of Vietnam, the Nguyen dynasty, designated Hue as the capital from the beginning of the nineteenth century until 1945. The tombs of the Nguyen dynasty in

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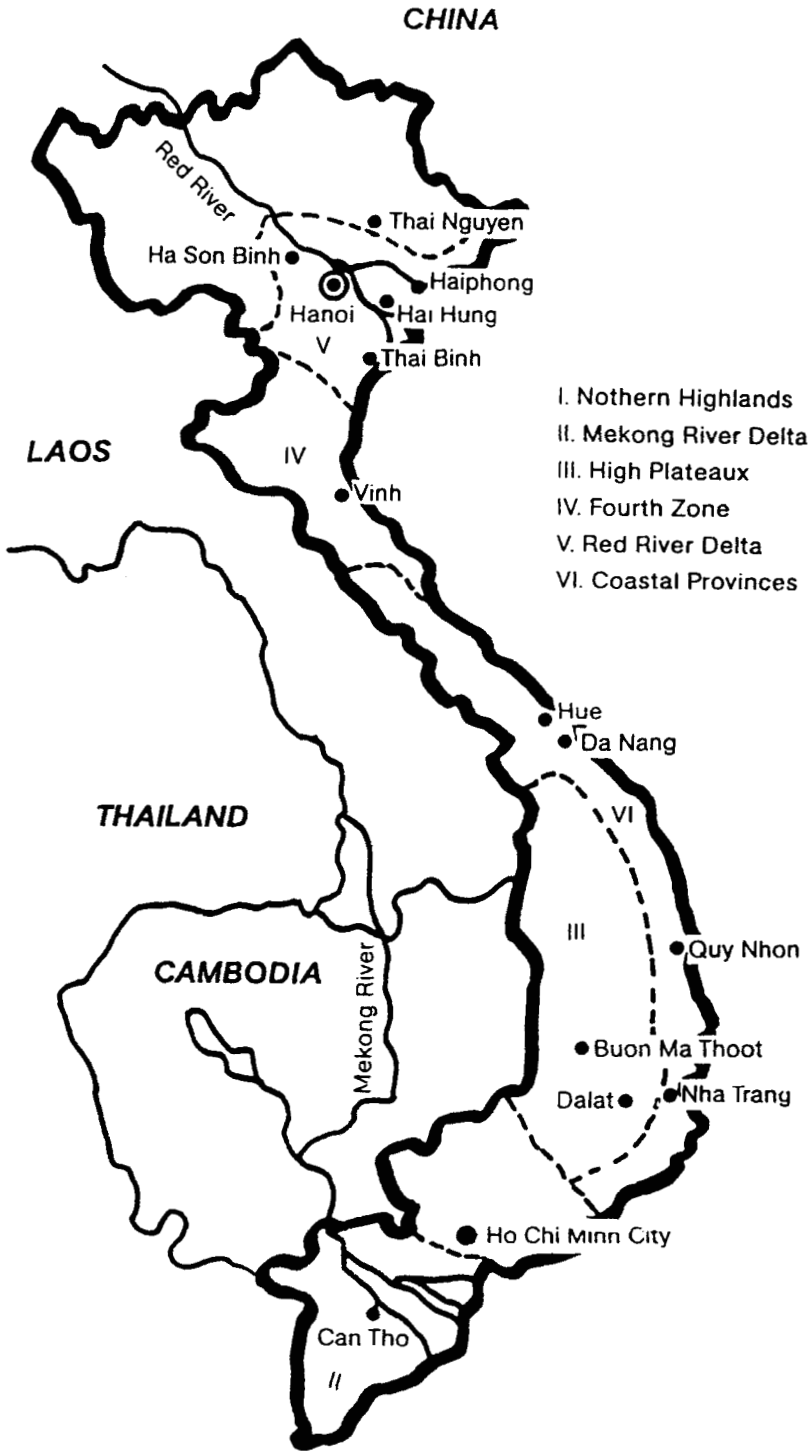
Dang Van Luyen



Dang Mai Huong



Otto Vogl



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Hue's Fortified Imperial City and Ha Long Bay comprises a spectacular landscape in the Gulf of Tonkin, 150 km south of Hanoi, and belong to the UNESCO World Cultural and Natural Heritage Sites of outstanding universal value. Ho Chi Minh City, or Saigon, with its almost 4 million inhabitants, is the largest city of Vietnam.

In this article we will describe the activities in polymer science in Vietnam. Up to now, polymer science and technology in Vietnam has developed mainly on the basis of such natural raw materials as

Natural rubber (more than 300,000 tons a year)

Oils: tung oil, castor oil

Laccol from *Rhus succedanea* in the North of Vietnam

Cashew nut shell liquid (CNSL) in the South of Vietnam

Rosin and turpentine oil

Shellac

Polysaccharides: cellulose, chitin and chitosan, alginate, agar, pectin

Considerable amounts of natural gas and oil have been discovered in Vietnam which are being explored for domestic use and for export. However, an efficient petrochemical industry still has to be built.

Vietnamese industry is focusing on the following three areas of the production of polymeric material.

Rubber processing: Vietnam, like Indonesia, Malaysia, and Thailand, possesses an abundant source of natural rubber. Rubber processing factories of various sizes have been built in Vietnam in which tires for cars, bicycles, and motorbicycles, as well as for electrical and mechanical accessories, are produced.



Paints and Coatings: The paint industry developed rather early in Vietnam due to the presence of various natural raw materials that can be used for paints and coatings. Examples are oil paints from tung oil, rosin, and turpentine oil; shellacs and varnishes for woodwork; and the sap of the lacquer tree for lacquered wood carvings. In addition, synthetic alkyd resins are processed into various surface protective coatings in some small-size factories.

Plastic processing: Most of the thermoplastic processing is done with polyethylene and polypropylene. Thermosetting resins for composite materials use polyester resins and epoxy resin. Glass fiber reinforced materials are produced in smaller plants for the production of small boats and household appliances.

Teaching and research in polymer science and technology is carried out in several universities, in the Institutes of the National Center for Science and Technology, and in the polymer research laboratories of some institutions of the government.

A. POLYMER SCIENCE AT THE UNIVERSITIES

Three major universities of Vietnam have been established in Hanoi, Ho Chi Minh City, and Hue. The University of Hanoi is the oldest university in Vietnam and was founded in 1945. In addition, there are also three major Universities of Technology in Hanoi, Ho Chi Minh City, and Danang. The first University of Technology was founded in Hanoi in 1954, the Hanoi University of Technology.



The Ha Long Boat-Wharf



Main Street, Hanoi

Research in polymer science is primarily carried out at the Hanoi University of Technology, at the Ho Chi Minh City University of Technology, and at the University of Ho Chi Minh City.

1. Hanoi University of Technology (Hanoi UT)

Hanoi UT is the largest institution of higher education in the northern part of Vietnam. Currently, it has a student population of over five thousand students. The



One Pillar Pagoda, Hanoi



Autumn in Hanoi

very first department of polymer chemistry was established here in 1966 under the direction of Professor Dang Van Luyen. The research of the department in these last 30 years has included the first scientific investigations ever done in Vietnam on oriental lacquers, paints from laccol and cashew nut shell liquid, on natural rubber, and on polymer composites. Many former members of this department are now heads of polymer departments and polymer laboratories throughout the country.



The Quan Thanh pagoda

The polymer science department at Hanoi UT is now headed by Professor Tran Vinh Dieu. Approximately ten scientists are involved in research and teaching. A broad area of research topics is conducted by Professor Tran Vinh Dieu and Dr. Le Thi Phai. They can be characterized as follows:

- Organic surface coatings including specialized coatings for food containers. Chemically resistant coatings are prepared for a variety of practical applications. These coatings are made from epoxy resins and laccol-modified epoxy resins (laccol is a mixture of alkylphenols and catechols with long side aliphatic saturated and unsaturated chains. Laccol is harvested from the sap of the lacquer tree of North Vietnam).
- Structural adhesives, such as high performance structural adhesives, and durable adhesive systems for rubber-metal bonds are being investigated.
- Advanced polymer composites are studied with regard to the effect of the fiber surface, the matrix resin, and interface modifications to achieve composites with maximum properties. The matrix resins range from phenolic-formaldehyde resins to epoxies and polyesters.

2. Ho Chi Minh City University of Technology (Ho Chi Minh City UT)

The department of polymer engineering in Ho Chi Minh City UT focuses its work on the development of new composite materials. The research groups of Dr. Nguyen Huu Nieu and Dr. Phan Minh Tan are interested in:

- Matrix resins used for composite materials which include unsaturated polyester resins, pure or modified with monoglycerides of soya-bean oil, epoxyester resin from epoxy resin and fatty acids from castor oil.
- Composite materials reinforced with natural fibers such as jute fiber – primarily polyester composites.



The Floating Hotel in Ho Chi Minh City

The relationships between monomer structure, degree of crosslinking, and the physical properties of composite materials.

3. University of Ho Chi Minh City

The department of chemistry at Ho Chi Minh City University is directed by Professor Chu Pham Ngoc Son. He and his coworker, Dr. Ha Thuc Huy, are carrying out research and development on natural rubber.

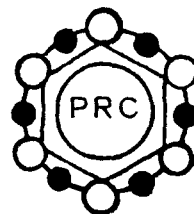
Depolymerization of natural rubber latex using phenylhydrazine- FeCl_2 and phenylhydrazine- H_2O_2 - O_2 system to obtain liquid natural rubber (LNR). Epoxidation of LNR by means of the formic acid- H_2O_2 system and fixation of α -naphthalene acetic acid onto epoxidized LNR.

B. POLYMER SCIENCE AT THE NATIONAL CENTER FOR SCIENCE AND TECHNOLOGY (NCST) OF VIETNAM

The NCST was established in 1975 as the biggest national research center of Vietnam and currently employs more than 2000 members on its scientific staff. Polymer science at the NCST is concentrated in the Institute of Chemistry and in the Institute for Tropical Technology.

1. The Institute of Chemistry (IC)

The Institute of Chemistry was founded in 1978. The Polymer Research Center (PRC), directed by Professor Dang Van Luyen, was established in 1987 to strengthen research on polymeric materials.



National Center for Science and Technology



The Perfume River and Mount Ngu Binh, Hue

Recently, the PRC was integrated into the IC. The research in which polymer scientists of the IC is involved covers a number of interesting areas of polymer chemistry and engineering with links to industries and universities. It not only involves polymer research within Vietnam but also has a number of cooperative projects with research institutions overseas. The research activities include research on:

Liquid natural rubber (LNR) and a series of LNR-possessing terminal reactive functional groups, such as $-\text{NH}_2$, $-\text{COOH}$, $-\text{NCO}$, epoxy, and methacryloyl. A number of these polymers were synthesized and the polymers that were obtained were used for the preparation of block copolymers (Dr. Pham Huu Ly).

Advanced polymer blends of natural rubber and phenol formaldehyde novolac resin (Dr. Pham Huu Ly), butadiene-nitrile rubber, and phenol formaldehyde resin (Dr. Pham Le Dung) are being developed.

The miscibility and compatibility of polymer blends are being investigated by using: 1) surfactants for enhancing the compatibility of polymer blends (Dr. Do Quang Khang); 2) cashew nut shell liquid (CNSL) for improving the processibility, tensile strength, and abrasion resistance of PE-, PP-NR blends (Professor Dang Van Luyen); and 3) the application of phenylhydrazine-terminated LNR for improving the compatibility of NR-PF blends (Dr. Pham Huu Ly).

Photoresists and their application for microimaging and presensitizing offset plates (Dr. Nguyen Duc Nghia) are developed.

Polysaccharides and biopolymers are being studied by: 1) extraction and gelation of polysaccharides (Dr. Dang Mai Huong); 2) synthesis of chitin, chitosan from shrimp shells; and 3) studying their derivatives and the use of these derivatives for applications in water treatment, agriculture, food processing, and medicine (Professor Dang Van Luyen).



An ancient street Hoi An, Da Nang

2. The Institute for Tropical Technology (ITT)

The current research subjects of the ITT include:

Polymer stabilization and degradation: investigation on the mechanism of stabilization and degradation of polymer with specific emphasis on the role of additives, antioxidants, and fillers; evaluation of the environmental effect on polymer degradation by means of spectroscopic, thermal, and mechanical techniques; investigation of the degradation and stabilization of



Dalat: Dawn in Xuan Huong Lake



At the old capital Hoa Lu

commercial polymers such as poly(vinyl chloride) (Dr. Tran Thanh Son, Dr. Nguyen Thac Kim).

Organic surface coatings: coatings based on cashew nut shell liquid resins for specialized applications such as antifouling coatings (Professor Vo Phien); protective coatings under the tropical conditions of Vietnam (Dr. Bui Thi An).

Epoxidation of natural rubber and liquid natural rubber, followed by acrylation and photocrosslinking of the obtained products (Dr. Le Xuan Hien).



Pongua Waterfall

C. POLYMER SCIENCE IN OTHER INSTITUTIONS

The research activities of the *Institute of Technical Chemistry* in Hanoi are involved in the epoxidation of natural rubber (NR) and NR latex, and the characterization and application of the epoxidized products for the preparation of adhesives for special purposes, e.g., adhesives for bonding to metals and steel conveyor belts (Dr. Nguyen Viet Bac).

The work in the *Laboratory for Radiation Chemistry* in the Nuclear Research Institute in Dalat is concentrated on studies of the vulcanization of NR latexes and of the crosslinking of polymers by high energy radiation (Dr. Nguyen Quang Hien).

The *Institute of Forest Science* in Hanoi focuses on the isolation and characterization of soda lignin from the bamboo black liquor and its use as an adhesive for plywood (Dr. Dao Viet Phu).

The *Institute of Industrial Chemistry* in Hanoi is investigating the use of complexes of dextran and other polysaccharides as a drug for piglets, as well as for drilling fluids; both research areas are based on polysaccharide research (Dr. Truong Dinh Thac).

THE DIVISION OF POLYMER SCIENCE OF VIETNAM

The *Division of Polymer Science of Vietnam (DPSV)* of the Chemical Society of Vietnam was created in 1990. Since 1993 the DPSV has been a member organization of the Pacific Polymer Federation (PPF). The chairman of the DPSV, Professor Dang Van Luyen, is a member of the PPF Council.



Le Van Nguyen, Yukio Imanishi, James E. Mark, Dang Van Luyen



R. Chujo, Dang Van Luyen, T. Takahiko, Y. Imanishi (President SPSJ)

The first international polymer symposium in Vietnam was organized by DPSV and the Chemical Society of Vietnam in January 1995 in Hanoi under the title *Polymers from Natural Sources (PNS-95)*. The Symposium was sponsored by the PPF and also substantially supported by the Society of Polymer Science, Japan. Over 50 invited lectures, oral, and poster presentations of about 80 participants from Vietnam, Japan, the United States, Australia, Malaysia, France, and China contributed to the success of the symposium. The contributions of this symposium are published in this special issue of the *Journal of Macromolecular Science—Pure and Applied Chemistry*. The symposium PNS-95 is just the beginning of an expected vigorous exchange and cooperation of Vietnamese polymer scientists with the international polymer society. It is expected to produce a close and permanent interaction of the scientists of Vietnam on a global scale.

The Vietnamese language, similar to other Far Eastern languages like Japanese, Chinese, and Korean, uses the family name first and the “given” name second: For example, *Dang* in Dang Van Luyen is the family name and *Van Luyen* the “given” name. In the Western usage of names, *Vogl* in Otto Vogl is the family name and *Otto* is the given name. In the use of most oriental names (Chinese, Korean, and Vietnamese), the family name has one character or syllables, in Japanese two characters, and the given name consists of two “characters” or syllables. This is not the case with Vietnamese any more, which does not use the “symbol” writing of the other Far Eastern languages.