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Centers of Polymer Research; Polymer Science in Czechoslovakia, Slovakia II: Universities and Research Institutes

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Polymer Science in Czechoslovakia: Slovakia II: Universities and Research Institutes

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In our last article we discussed, how various institutions are interacting in research and teaching of polymer science and engineering in Slovakia, one of the two Federal Socialist Republics of the Czechoslovak Socialist Republic. Particular emphasis was given to the research activities in the Polymer Institute, Center of Chemical Research of the Slovak Academy of Sciences in Bratislava, since it constitutes the greatest concentration and effort of research in macromolecular science in Slovakia. While it is the major center of research in polymer science and engineering, teaching of polymer science is primarily carried out at the Slovak Technical University in Bratislava; nevertheless, a considerable amount of research work for advanced degrees is also done at the Polymer Institute. In fact, some of the research staff of the Polymer Institute have joint appointments or are also scientifically active at the Technical University.

Slovak Technical University; Faculty of Chemical Technology, Department of Chemical Technology of Plastics and Fibers

The Department of Chemical Technology of Plastics and Fibers was founded in 1943 at which time it was called the Department of Organic Chemical Technology. Teaching here focuses on two areas: (a) the chemical technology of plastics and rubbers, having about 30 students per year, and (b) chemical fibers having about 20 students per year.

The research efforts in the Department of Chemical Technology are centered around three areas of polymer chemistry: (a) radical polymerizations and chemical modifications of polymers, (b) the effects of additives on rheological and other properties of polymers, and (c) chemical and physical processes governing the actual production of synthetic fibers.

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Three different groups are working on problems of radical polymerizations and of chemical modification of polymers under Professor Jozef Beniska who is also head of the department and a specialist in the chemistry of rubbers. Associate Professor Emil Staudner and Dr. Gabriela Kysela (Mrs.) are studying the reactivity of selected sulfur and

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nitrogen containing compounds in polymeric systems with special emphasis on reactions of tetramethylthiuram disulfide (TMTD), because TMTD can function as an initiator for the polymerization of some vinyl monomers and also can be used to control polymer molecular weights; in other cases TMTD can act as an inhibitor for radical polymerizations. The redox system TMTD/hydrogen peroxide and similar peroxide containing combinations are also studied for their effectiveness in radical polymerizations.

Professor Alexander Hrivik's research interests deal primarily with methods for the stabilization of polymers from vinyl compounds and dienes. He is also investigating the retardation or inhibition of thermally or radically initiated polymerizations of vinyl monomers by substituted hydroxylamines and nitroxides; he uses the kinetic studies which are compared with the results of ESR studies.

Under Professor Darina Mikulasova (Mrs.), Dr. Viera Chrastova (Mrs.) and Dr. Pavol Citovicky are working on the development of new methods for the synthesis of polymers and copolymers of extremely high molecular weights. Their method is based on the use of polymers, such as polyethylene, polypropylene, poly(vinyl chloride), inorganic compounds like natural zeolites or metal oxides as the carriers for the initiators which are placed and bonded to the carrier surface. These supported initiators, usually in powder form, are used as initiators in emulsion polymerizations. By this general method it is also possible to prepare graft copolymers; for example, acrylic acid or glycidyl methacrylate were grafted onto polypropylene.

A second general area of polymer research, also coordinated by Professor Beniska, is carried out in two laboratories. One group, headed by Dr. Eugen Spirk, is investigating stabilizers for polymers: a) optimization of stabilizer concentrations and b) discoveries of synergistic mixtures in mixed stabilizer systems. Special emphasis is given to physical factors during processing which influence the effectiveness of the stabilizer in the final product. For example, in extrusion processes, the method of mixing the stabilizer with the polymer is believed to have a profound effect on the subsequent rate of migration, evaporation or leaching of the stabilizer. The other group, headed by Dr. Anton Marcincin, is interested in the interactions between polymers and pigments. Particularly the dyability of polypropylene in bulk is being investigated.

The fiber research program is led by Professor Alexander Pikler and involves the largest group in the department, with about 20 people. The thrust of the research effort is directed towards fiber modification by chemical or physical means with the objective of imparting specific properties onto fibers, such as antistatic properties or stain resistance. Another research area being investigated in Professor Pikler's group concerns rheological changes in the polymer melt, particularly during the spinning process. The transport of liquids through spun fibers is also being studied.

Professor Martin Jambrich and his group are primarily interested in the investigation of the supermolecular and morphological structure of anisotropic polymeric systems in the solid phase and in melts.The group is also investigating the effects of changes in the structure of fibers on the final mechanical properties of the fiber that might occur during the spinning process. Spectroscopic methods like x-ray, electron and infrared spectroscopy, are used in this investigation.

The Research Institute for Petrochemistry, Novaky

The Research Institute for Petrochemistry in Novaky, was created in 1950 by separating the research activities from what is now the Chemical Plant of W. Pieck in Novaky; the Institute has as its director Dr. V. Macho. From the beginning the research was involved with acquiring basic knowledge and improvement of the production of monomers expecially vinyl chloride and vinyl acetate and on their polymerizations. Over the years the quality of poly(vinyl chloride) was improved and the types of vinyl chloride polymers were increased. An improved synthesis of vinyl acetate, its polymerization and the production of vinylidene chloride and its copolymers were developed.

In the last decade further improvement in the production of polymers and copolymers of vinyl chloride were made, particularly by paying attention to new initiator systems. In addition to the development of initiation systems prepared "in situ", improved dispersed systems were developed for the production of the suspension types of poly(vinyl chloride). These results have been put into practice by introducing new commercial products of poly(vinyl chloride) S-PVC, SLOVINYL 683 and SLOVINYL S 622.

Attention is also given to broadening the use of the poly(vinyl chlorides); a type of chlorinated poly(vinyl chloride) was prepared by suspension chlorination which allows applications with use temperatures in excess of 100°C. It is well known that introduction of additional chlorine atoms into the chain of poly(vinyl chloride) influences a number of polymer properties, for example, an increased softening point, higher strength and higher impact resistance.

Critical poly(vinyl chloride) properties were also modified by copolymerization of vinyl chloride with other suitable comonomers, for example propylene. Good internal plasticization was obtained by introducing propylene units into the polymer chain of poly(vinyl chloride). By this technique, migration, blooming and leaching of the plasticizer (the propylene portion of the polymer) is avoided, and the properties of the polymers do not change with time as a result of "physical aging". These observations are complementary to the recently observed effectiveness of polymeric antioxidants and polymeric ultraviolet absorbers and firmly establishes the principle of polymeric stabilizers as a viable concept

with a very promising future. The melting temperature of these copolymers is also lower than that of common poly(vinyl chloride). The product is now commercially available under the trade name SLOVINYL KP 031.

Toughness and impact resistance were improved by grafting vinyl chloride on copolymers of ethylene and vinyl acetate to a product with good processability and increased toughness. New types of vinyl chloride homopolymers and copolymers also made possible the production of pipes with 100 to 125 kp/cm^2 in Plastika, Nitra national enterprise.

Polymers and copolymers of vinyl chloride are also used for discs for quality recordings; other types of vinyl polymers have been successfully used in the furniture industry; they are now being increasingly accepted in the building industry.

Recently a great deal of attention is being paid to the lowering of residual amounts of vinyl chloride monomer in poly(vinyl chloride). Problems of monomer removal were solved by various techniques; some of these techniques are now being used to eliminate residual vinyl chloride on an industrial scale.

In a combination of basic and applied research, scientists of the Institute have worked successfully on the technological developments of unsaturated polyester resins, produced under the trademark PATIX. The properties of these materials have been optimized and the resins are used for floor coverings.

Additives used in unsaturated polyester resins were studied in order to increase the electrical conductivity of transparent of filled unsaturated polyesters.

Polyurethanes are also the subject of investigation of a research group in the Institute. Special polyurethane foams play a role in shoemaking; the optimization of the properties was accomplished; the influence of individual components, the type and structure of the addivites were adopted to the technology of processing to influence the structure of the foam and to obtain ultimate properties of the polyurethane products. The polyurethane foams are now being used in the plant of 29th August, Partizanske. More recent studies involve the possibilities of utilizing the side products from petrochemical processes for the production of monomers, especially for the production of the polyester/polyol component which is planned to be used for hard polyurethane foams.

The Research Institute of Processing and Application of Plastics, Nitra

The ancient city of Nitra, which was known in the period of the Great Moravian Empire, is the third largest city in Slovakia with more than 70,000 inhabitants. It is an important center of industry, agriculture, higher education, culture and sport. It is a district town with many important historical and cultural monuments.

In the early 60's construction of the industrial complex Plastika Nitra for the production of plastics materials was started. The research base for the support of the production of plastic materials, the Research Institute of Processing and Application of Plastics (RIPAP), was created in 1974 as an independent organization of Slovchemia. Nitra has consequently become an important center of research and production of plastics materials in Slovakia.

RIPAP has 200 employees, with academically trained professionals presenting the predominant majority. A number of qualified technicians are active in the machine shop of the Institute which insures the maintenance of instruments and tools necessary for various processes of the plastics production. The research activities of the Institute are concerned with the (a) development of processes for the preparation of poly(vinyl chloride), polyethylene and polypropylene films, (b) development of extrusion technology, blow molding and orientation, (c) development of the technology for the fabrication of poly(vinyl chloride), polyethylene and polypropylene pipes, (d) elimination of problems of polymer decomposition, combustibility, antistatic finish and modification of plastics, (e) quality increase of polymeric products of large dimensions and the maintenance of dimensional accuracy of products prepared by injection molding and the increase of the injection molding rate, (f) search for new raw materials and the development of the technology of new products, (g) quality testing of plastics materials produced within the responsibility of the Ministry of Industry of Slovakia, (h) and research, development and production of prototype machine equipments and tools for the control of the technological processes.

Research Institute of Man-Made Fibers, Svit

The Research Institute of Man-made Fibers in Svit is an industrial research institute; it is under the directorship of Dr. Ivan Diacik, has over 500 people and is responsible for research, spinning and evaluation of synthetic fibers. The Institute is concerned with basic research on new types of synthetic fibers, and the development of methods for their fabrication.

Research in the Institute is concerned with the optimization of the properties of polypropylene, poly(ethylene terephthalate), Nylon 6 fibers and the production of biaxially oriented films. Objectives are to improve spinning performance and mechanical properties of fibers, to reduce the static charge and flammability of fibers and to increase the dye receptivity.

Polypropylene Fibers: Major efforts are in the development of polymers with molecular weights of about 200,000 and a relatively narrow molecular weight distribution. Research is also underway to control polymer degradation initiated by radical degradation processes. Polypropylene with increased light stability based on sterically hindered amines as photostabilizer/autioxidant is also the subject of research in this area.

Polyester Fibers: Poly(ethylene terephthalate) is being chemically modified by copolyesterification with sulfonated isophthalic acid. Other copolyesterifications, especially with isophthalic acid, are being used for the production of modified polyester fibers.

The polyester research in the Institute is specifically concerned with the development of technological development of polymer dying in substances for several different color shades, including black.

Modified Nylon 6: The Research Institute of Man-Made Fibers is also involved in the modification of the properties of Nylon 6. Optimizing the polymer blends to improve dye receptivity is a major effort in this research. One of the approaches is the use of condensation polymers of ε-caprolactam with copolyesters of dicarboxylic acids and substituted poly(alkylene oxide) glycols.

Poly(2-pyrrolidone): Research to prepare synthetic fiber with the hygroscopic properties similar to cotton have been carried out successfully by using poly(2-pyrrolidone) as the polymeric blending component and compare favorably with the commonly used polyesters and polyamides blends.