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Macromolecules in Graz, Austria, December 3, 2004

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Conference Report

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In the last few years, Central Europe was the location of important, smaller but highly focussed conferences on Polymer Science. Last year there was a conference in Slovakia in the Tatra Mountains, called *ModPol2003*. Two years ago the conference "Macromolecules in the 21th Century" was held in Vienna, attracting over 200 participants from all over the world.

Volker Ribitsch

This year a conference was held in Graz, Austria, in the state of Styria. Graz is a focal location of polymer science in Austria and surrounding countries. The occasion was the 80th birthday of one of Europe's leading scientists, Josef Schurz. His expertise and major contributions in cellulose chemistry and rheology have been well recognized in the past.

Jane Vogl and Sepp Schurz

Graz

The meeting was held at the University of Graz, specifically the Institute of Physical Chemistry. For two decades, Schurz ha

been the director and the guiding light for this Institute and its development into a world recognized institution.

Clock Tower

The meeting was organized by Christoph Kratky, Otto Glatter, and Volker Ribitsch, three Professors of the Institute. It was held in the Meerscheinschlössel, a traditional building adjacent to the Institute. About 100 people, colleagues, friends and students attended the meeting. It was also attended by the former governor of Styria, Josef Krainer, and the former Rektor of the University of Graz, Heinz Mitter, as well as other dignitaries of the University.

Meerscheinschlössel

After the traditional Introduction, which included a musical performance, Christoph Kratky presented the laudatio for Josef (or as he is also called by his friends, "Sepp") Schurz describing his scientific accomplishments and some of his life interests. The first speaker, Erich Gruber, was introduced by Otto Glatter and the second speaker, Otto Vogl, by Volker Ribitsch.

Christoph Kratky and Mona Schamberger

Christoph Kratky in his introduction (laudatio) of Professor Schurz, praised him for his accomplishments as a scientist and teacher and his activities in professional societies, especially his foresight in organizing new groups such as the group of theology in Austria. Schurz is a member of the Austrian Academy of Sciences and has received a number of honors and awards, including an honorary doctoral degree from the Polytechnic University in Iasi, Romania.

In his talk, Christoph Kratky concentrated more on Schurz as a person and friend. He pointed to his special interests and concerns about his students, his life with his colleagues, and his family.

Schurz's personal interests are concerned with philosophy and nature. He is particularly proud of his life in the mountains, mountain climbing, skiing, and he has published a nature guide of his beloved Styria. Schurz is also involved in a philosophy discussion group that meets on a weekly basis.

Otto Glatter

Erich Gruber, Head of the Cellulose Research Division of the Technical University of Darmstadt presented his view on Cellulose Research

The specific properties of cellulose are not based on its chemistry but rather on its molecular and supra molecular structure. This already becomes evident by comparing cellulose to starch. So this survey of cellulose research focuses on views of cellulose structure, which were obtained within about 150 years, and to which Schurz contributed his share. Even if there are some *puzzle* stones missing, we are getting nearer now to a comprehensive picture of the hows and whys of the constitution of cellulose.

Erich Gruber

A look to the various structures at increasing levels of complexity reveals that each of the morphological traits seems to be optimal for the role cellulose plays in nature as if all these structural traits were controlled by a principle of finality. Schurz drew attention to such a phenomenon controlling the fibrillar structure of algae cellulose. However, later similar fibrillar structures were discovered also in regenerated cellulose, which are undoubtedly controlled by simple thermodynamics of cellulose solutions and the conditions of reprecipitation.

Among all sugars the building block glucose is the most appropriate one to build tough and strong materials by its unique capacity of forming exactly positioned hydrogen-bridges. Nevertheless there are 3 crystalline allomorphs, two of them containing parallel chains, which are found in native cellulose and are metastable, while the allomorphous cellulose containing inversely orientated chains is formed by regeneration.

Concerning the supermolecular arrangement, quite a number of models have been suggested and tested. Now it is widely accepted that it is essentially dominated by a fringed crystallite structure. But again, slight differences are found in detail. Although in native cellulose this morphology is probably mainly controlled by the accompanying hemi celluloses, in regenerated cellulose some chain folds impede far-reaching crystallization. A fringed crystallite arrangement is the prerequisite for optimal mechanical performance of such a material. Although the structure of celluloses at the level of colloidal dimensions only differs slightly, we observe an enormous range of variation among cellulosic tissues of different origin. Such structures are in no way controlled thermodynamically, but tailor made by the membrane fixed devices of biosynthesis, which are specific for a given organism. Strictly speaking no specimen of cellulose is in its thermodynamically stable form, its structure being controlled by the process of fibril formation.

The structure of native cellulose is always the result of synthesis by a specific enzyme complex, which has been optimized by evolution to produce optimal structured cellulosic tissues.

Otto Vogl came from Amherst, Massachusetts, where he is the Herman F. Mark Professor of Polymer Science Emeritus at the University of Massachusetts to honor his friend, Sepp. He gave a lecture on Macromolecules and the Modern World.

Over the last century macromolecules have become a very important factor in our lives. About 5% of the Gross Domestic Product in the United States involves materials that rely on synthetic macromolecules. We can really claim that we have reached the Plastics Age. Older cultures have used stones, metals, and natural materials such as hides and bones or composites of natural materials. We are now producing about 220 millions of tons, mostly from oil, which is harvested in amounts of 4 billion tons. Two thirds are commodity plastics, 60 million tons of polyethylene, 35 million tons of polypropylene, and nearly 30 million tons of PVC.

Otto Vogl and Gretl Schurz

At the same time the world produces plant growth products of about 20 tons per person per year, mainly cellulosic materials by photosynthesis. These plant materials are the source of energy for the future, and it is our responsibility to find low cost ways to utilize these renewable resources to materials that we know and are accustomed to using.

We do not expect to find and develop many new plastic materials, but we will have to learn to produce them cost-efficiently and with more and more desirable properties and needs.

This can be done by modifications or more efficiently by blending known materials.

We must learn to use the production of the materials from monomers directly with higher catalyst efficiency, with higher polymer yield per catalyst unit, at the lowest energy costs and directly into useful forms for further fabrication.

We must learn to prepare appropriate blends and modifications directly without any isolation and work-up.

As a second item, the author pointed to the importance of our knowledge of the structure of materials. He mentioned structures of polypropylene, hexafluoropropylene, and polychloral. Polypropylene can now be prepared with various degrees of tacticity, various combinations of isotactic and syndiotactic structures, and their combinations in the polymer chains and molecular weights and molecular weight distributions.

Isotactic polypropylene consists of equal amounts of left- and right-handed polypropylene chains. An unsolved problem in polymer science is the preparation of polypropylene with chains of one handedness by crystallization. The synthesis of a chiral single chain has been already accomplished with polychloral, but in this case the polymer is a rigid isotactic polymer.

Vogl also mentioned the importance of knowing and appreciating the importance of spacer groups in polymer structures and their reactivity.

Much of the immediate direction in polymer science is related to our appreciation of nature. Vogl asked the question, What can nature teach us? Much of it has to do with the understanding and mimicking of hierachal structures that nature can produce, especially self assembly and structures with proteins that transport molecules throughout our body for it to function efficiently. He also mentioned reactions that have been observed and are utilized that use proteins as catalysts, including the synthesis of cellulose and other polysaccharides.

Of most visible and immediate importance are the directions that we are observing in the awe-inspiring development of biotechnology.

Finally, Vogl focused on the importance of our responsibility for our culture and history: Polymer Science and the Arts. In recent work in Texas it was found why a Stradivarius violin sounds like a Stradivarius. The influence of polymer science on the restoration of old masters, the restoration of frescoes on the silk road, and of the cathedral in Cologne were also mentioned.

Vogl played an active part in the analysis of Oriental Lacquer and the painting and curing technique on art objects, using urushi, the active component of the Oriental Lacquer.

In closing, Vogl pointed out that he described only a few subjects where macromolecules play an essential part but more subjects could have been mentioned to demonstrate the importance of macromolecules in the Plastics Age.

After another musical interlude, the meeting was concluded and the participants enjoyed a buffet lunch in the foyer of the Meerscheinschloessel.

Hacuserl am Wald

On the evening of December 3, 2001, the speakers, organizers, and a few honored guests were invited to an elegant dinner at the Restaurant "Hacuserl im Wald." This is a famous restaurant located in the hills of the suburbs of Graz. It was the season where game, duck, and goose are prominent on menus of this part of the country. We all wished Sepp many more years of happiness and good health, which concluded a most delightful scientific meeting.

Helga Katzer and her Colleagues

Acknowledgments

We would like to thank Helga Katzer for her dedication and assistance during the preparation for the meeting and for this manuscript.

An article about Josef Schurz, describing in detail his scientific accomplishments, appeared a few years ago and was published in *Polymer News*: Otto Vogl and Gretl Koller-Schurz, *Josef Schurz, Polymer News, 24(2)*, 51-52 (1999).