CHIMIA 52 (1998) Nr. 1/2 (Januar/Februar)

CONFERENCE REPORTS

Chimia 52 (1998) 73
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ISSN 0009–4293

International Symposium on Solar Chemistry

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On October 6–8, 1997, the International Symposium on Solar Chemistry was held at the Paul Scherrer Institute in Villigen, Switzerland. The overall scope encompassed solar-driven thermochemical and photochemical processes for the production of energy carriers (solar fuels), the processing of chemicals, the detoxification and recycling of waste biomass.

The symposium's objective was to create a forum for discussing the state of the art on solar chemical technologies and for coordinating efforts towards research, development, and demonstration of these technologies. It should further help to arise the public awareness on the potential of solar chemistry to contribute to clean, sustainable energy services. The symposium committee, therefore, invited 13 speakers to report on the current status of their particular field. The scientific program was completed by more than 50 poster presentations.

The symposium was organized and sponsored by the Swiss Federal Office of Energy (BEW), the High-Temperature Solar Technology Section of the Paul Scherrer Institute (PSI), the Research Center for Carbon Recycling and Utilization at the Tokyo Institute of Technology (TIT), and the Solar Research Facilities Unit of the Weizmann Institute of Science (WIS).

This report shall provide the reader with an overview on current activities and important issues in solar chemistry. A comprehensive collection of papers, presented at the conference, will be published in a special issue of *Thermochimica Acta.*

In the opening talk, *A. Wokaun* (PSI, Switzerland) emphasized the role of solar chemistry in a sustainable energy system. Renewable energies are nowadays an approved energy vector for the next century. To fulfill this task, solar technologies have to be developed and implemented. He illustrated that solar chemistry encompasses a variety of techniques and applications.

Solar Fuels

Hydrogen was identified as an important energy carrier for the future. A promising route for a sustainable hydrogen production is water splitting by means of metal oxide based thermochemical cycles. Such cycles are currently under investigation, *e.g.*, at the Paul Scherrer Institute. An alternative approach was proposed by *H. Arashi* (Tohoku University, Japan). He presented a solar receiver that eventually will allow the electrolysis of water at elevated temperatures with solar radiation as the only energy source.

Strategies for Market Penetration

Solar fuels will be competitive only in a future energy market, where prizes for fossil fuels will have considerably increased either because of economic reasons or political measures. However, a gradual penetration into the present market is considered to be crucial for a steady growth of solar technologies. *A. Yogev* (WIS, Israel) analyzed the situation on the energy market and presented a possible strategy for a gradual market penetration. He recommended stronger efforts to organize joint projects with industry, further to cultivate a continuous dialog with industry to build confidence, and to be aware of the needs of the market.

Synthesis of Fine Chemicals

An alternative strategy was presented by *G. Flamant* (Institut de Science et Génie des Materiaux et Procédés, Odeillo/France). His and other groups attempt to enter the market these days with solar niche production of fine chemicals, such as fullerenes, carbon nanotubes, or nanosized metal oxide particles. They expect to significantly reduce production cost of these chemicals by using cheap raw materials and concentrated solar radiation.

Concentrated Solar Radiation – A Unique Energy Source

G. Flamant stressed in this context the unique properties of concentrated solar radiation and the resulting applications. Concentrated solar radiation is characterized by high flux densities, high temperatures, and large gradients with respect to time and space. Thus, it offers unique opportunities for high-temperature synthesis and transformations.

Solar Radiation as a Source for Process Heat

J. Lédé (Laboratoire des Sciences du Génie Chimique, Nancy/France) discussed the potential of biomass gasification to coproduce gas mixtures, such as syngas, and electricity. The gaseous products will be further processed to energy carriers (*e.g.*, hydrogen or methanol) or chemical commodities. An alternative thermochemical conversion of biomass can be achieved by pyrolysis. The process heat to run both the gasification and the pyrolysis can be supplied by solar receivers in a straightforward way, and an environmentally friendly recycling of waste biomass can be achieved.

Photoelectrochemical Water Splitting

All processes mentioned above utilize solar radiation as a source of thermal energy. In addition, enormous efforts were undertaken to use the photons to convert solar radiation into chemical energy, particularly to split water into hydrogen and oxygen. *J. Augustynski* (University of Geneva, Switzerland) presented a yet unique photoelectrochemical tandem cell. This device uses a large fraction of the solar spectrum to split water and yields attractive chemical conversions.

Photodetoxification with TiO_2

Photodetoxification of organic pollutants employing titanium dioxide (TiO_2) is probably the only solar-driven process that is at the edge of being commercialized. Pilot plants were built, *e.g.*, in Spain, and collaboration with industry was established. *M. Romero* (CIEMAT/DER, Madrid, Spain) reported recent hardware improvements and development of catalysts that will yield higher throughputs and efficiencies. He found that the promising degradation efficiencies often contrast with a poor understanding of the chemistry involved in the degradation. Better understanding might be crucial for an industrial implementation of this technique. Research to acquire this knowledge should be encouraged.

The symposium organizers honored two pioneers of solar chemistry: *P. Kesselring* (PSI, Switzerland) and *E.A. Fletcher* (University of Minnesota, USA). Although they live far from each other, they share a common vision for the future: They see solar fuels as the energy vectors for the 21st century. As teachers and researchers, they have contributed enormously towards making this vision reality.

In conjunction with the symposium, a new high-flux solar furnace was inaugurated at PSI. It consists of a 120 m^2 flat heliostat on axis with a 8.5 m diameter membrane parabolic concentrator, delivering 45 kW with a peak concentration of 5000 suns. The new solar facility will be used as a research platform for developing and testing high-temperature chemical reactors for the production of solar fuels. In addition, it will serve as a 'user lab', and thereby promote PSI's mission to provide large facilities for the national and international research community.

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