Conference address

We are met here in Osaka to participate in the Fifth International Conference on Photochemical Conversion and Storage of Solar Energy (IPS-5) and in view of the nature of the program I thought that it would be appropriate to say a few words about my view of how the field is developing. While it appears that the first conference under this sponsorship was held in London, Ontario, Canada, in August 1976 with James Bolton as the organizer, the remaining meetings have been held in Cambridge, England (organizer, Mary Archer), Boulder, CO, U.S.A. (organizer, John Connolly), Jerusalem, Israel (organizer, J. Rabani) and now, in 1984, in Osaka, Japan.

A meeting took place in September 1977 in the institute of Professor Matsuo, in Fukuoka, Japan, immediately following the IUPAC meeting in Tokyo, under the title "*Biomimetic Chemistry*". This included talks on photosynthetic model systems, and that part of the discussion actually belongs in the present IPS series.

A review of the present program, as well as past programs, clearly shows the influence of our developing knowledge of natural photosynthesis on the wide variety of systems being discussed here. The more we have learned about the molecular details of the natural quantum conversion process in green plants, the more we have become convinced that the essential physical–chemical feature which has evolved in nature to accomplish this feat requires photo-induced electron transfer across a phase boundary and the inhibition of the back reaction by virtue of these phase boundaries, charged or uncharged. In natural photosynthesis it seems to be a combination of a microscopic phase boundary, represented by the large chromophore-containing protein molecules which have hydrophilic cores and hydrophobic shells, further organized into macroscopic phase boundaries as membranes.

This concept of artificial photosynthesis was conceived and first simulated in Berkeley, CA, using bilipid layer vesicles

with sensitizers on both sides and different catalysts on the inside and outside to create an unsymmetrical membrane. The microscopic phase boundary has been modeled by Lehn in France, and perhaps in the Bolton experiments as well.

This same notion encompasses the use of semiconductor surface potentials for the separation of the photo-induced charges. In fact, the case in which a porphyrin sensitizer was applied to a semiconductor in this concept was described by Tributsch working in Berkeley in 1970. Today the realization that the sensitized semiconductor surface does indeed simulate the natural process is further strengthened by a French review (Rodot of the Centre National de la Recherche Scientifique and Bianchi and Peter of Total-Compagnie Française des Pétroles) in which natural photosynthesis and semiconductor conversion are compared. A similar relationship was used by Grätzel in his earlier work.

While it may be possible to devise apparently homogeneous molecular systems involving reversible chemistry in which recombination is somehow inhibited, I dare say that these will eventually turn out to be microheterogeneous systems in the sense mentioned earlier.

The program of this meeting as exhibited in terms of the titles of the plenary lectures, the invited lectures and the panel discussions is closely related to and developed from this basic concept, even though the use of semiconductors for quantum conversion as well as a number of other systems were initially devised quite independently of it. An example is Honda's discovery in 1972 of the photoevolution of oxygen on a titanium oxide surface.

Today I think that we can see the enormous evolution and variety of systems in the light of the growth in knowledge of natural photosynthetic processes which has occurred. This single concept (phase boundary separation) brings together all the subject matter in the program as we now see it. We can expect a further development and convolution of this phase boundary electron transfer concept as the detailed molecular knowledge of the natural photosynthetic process evolves. We can then suggest totally new synthetic systems to fulfil the high quantum efficiency of electromagnetic-to-chemical conversion which we seek.

I look forward to the reports of this meeting and the promise of future meetings.

MELVIN CALVIN
Department of Chemistry, and
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720
U.S.A.