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Introduction

With increasing population and economic growth in large parts of the globe, there is a rapidly growing need for energy that cannot be met by increased use of fossil fuels due to their limited availability. At the same time, signs of global warming due to human CO_2 emissions make a paradigm shift toward carbon free energy sources urgent. It is expected that the increased energy demand cannot be met by one single solution, but rather by a large number of different sources combined with more efficient energy use.

One of the most promising fuel sources is hydrogen which can be produced in a number of different ways, but the most environmentally beneficial and sustainable way is through solar light which is available in abundance. This can of course be achieved by electrolysis of water using electricity produced separately by solar cells or solar thermal techniques, but perhaps the most elegant and cost-efficient way will be to use the solar energy to decompose sea water directly by an inorganic or biological catalyst. However, this is not an easy task to achieve efficiently and in spite of large and growing research efforts in this promising area, there is still much to learn before large scale application can be achieved.

Inorganic catalysts have been the main concern of the participants in the Solar Hydrogen and Nanotechnology conference series. Development of such direct hydrogen catalysts represents one of the most difficult tasks in materials science due to the complex, multifunctional nature of a solar hydrogen cell encompassing photo generation of hole-electron pairs and their transport to the surface to perform different reactions eventually yielding H_2 and oxidized species at the surface. Increased knowledge in this area has led to more and more complex structures with different parts of the nano-structures optimized for different functions such as generation of hole/electron pairs by visible light and surface added co-catalysts to facilitate the H_2 and O_2 generation. From the presentations, it is clear that many types of semiconductors and morphologies are under investigation, but at the same time chemical and photo-corrosion has to be considered in order to prepare a time stable system which limits the choices of materials. One can also see a steady increase in the understanding and efficiency of the cells which strongly indicate that this is a feasible way of generating renewable fuel.

However, this area is still in its infancy searching for different paths to investigate and for the coming years, many different alternative approaches to solar hydrogen generation will be pursued and compared on their different merits. Thus, development in this field is truly a multidisciplinary endeavor requiring knowledge from broad teams of experts from many areas of science which has been shown in the presentations including for example, chemical and physical state-of-the-art materials preparation techniques; detailed experimental and

theoretic surface reaction studies and band-structure analyses; and different approaches to hydrogen generation from other sources than water.

When designing materials that will be produced in very large scale and utilized in a decentralized manner, there is also a constraint in not using potentially environmentally detrimental materials. Another constraint pointed out by Professor Craig Grimes in his plenary talk, is to use materials that are not at risk becoming a limiting factor due to a low abundance.

This conference series on Solar Hydrogen and Nanotechnology is running in its third year providing a forum for discussion of science and technology for solar hydrogen bringing experts of different fields needed for development of the area together. The conference has since its start attracted a large part of the leading researchers in the field from all over the globe, as well as leading experts in related and needed areas for development of solar hydrogen generation catalysts, and I dare to say that it has become one of the most important arenas for discussion in this field.

Finally, I wish to thank all contributors, whether plenary, invited, or contributed speakers, or participants for the consistent high level of the talks and discussions. I am particularly pleased to see the very open and collaborative atmosphere between the participants during the conference, as well as the many new acquaintances and collaborations formed. I also wish to take the opportunity to thank the SPIE staff and the Solar Hydrogen and Nanotechnology program committee for the good support.

Gunnar Westin