Light-Induced Water Splitting and Hydrogen Production in Nature: Basis for the Design of Bioinspired Molecular Catalysts

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Storage of the sun’s energy in „solar fuels“ like molecular hydrogen or related molecules using water as a basic material is a research topic of great importance for our society.

A promising start point for the development of synthetic sun light-driven water splitting catalyst, is to use Nature’s approach for inspiration that is realized by the tetranuclear manganese cluster in photosystem (PS) II of oxygenic photosynthesis.¹ Many bacteria and green algae also contain enzymes that enable hydrogen evolution from excess protons, the hydrogenases.²

In recent years high resolution X-ray crystallographic structures of PS II⁴ and different hydrogenases²,³ have been obtained and additional spectroscopic and electrochemical experiments have very significantly increased our knowledge about the structure and function of the native enzymes leading to a mechanistic understanding of the underlying processes. This knowledge will help to advance the field of artificial photosynthesis, aiming at synthesizing new catalyst for large scale water splitting, hydrogen production or energy storage in other chemical compounds, processes that are of key importance for a sustainable energy future.

In this lecture the native metalloenzymes wateroxidase and hydrogenase are presented and their working mechanisms are discussed. Prospects of native biological and artificial chemical systems to solve the energy problems will also be addressed.

References