Elektrocheminės Medžiagotyros Seminaras

Wojciech Macyk

Head of Photocatalysis Research Group, Faculty of Chemistry

Jagiellonian University, Krakow, Poland

Energy uphill and downhill reactions – what is the potential of photocatalysis?

Professor W. Macyk is a distinguished researcher in the fields of photochemistry, photocatalysis, and semiconductor photoelectrochemistry. He leads the Photocatalysis Research Group at the Faculty of Chemistry of Jagiellonian University, where he also currently serves as Vice-Rector for Research

There is a fundamental difference between the photocatalytic oxidation of pollutants and the photocatalytic production of solar fuels. Similar to combustion, the oxidation of pollutants is an exergonic process, whereas water splitting or carbon dioxide reduction is an endergonic reaction. In energy-downhill processes, absorbed light is used to overcome the activation energy of elemental steps, e.g., the activation of oxygen or a C-H bond. The role of photons is, therefore, to "ignite" the energy downhill reaction. However, the production of hydrogen from water or of methanol from CO_2 is a highly endergonic reaction. Photocatalytic production of solar fuels is the conversion of solar quantum energy into the energy of chemical bonds. In such processes, photons can be considered as reagents. This differentiation is crucial for understanding the theoretical limit of quantum efficiency achievable in these types of processes. In uphill energy reactions, the energy gain (the energy of chemical bonds) originates from photons. One absorbed photon can generate one e^-/h^+ pair, which can be used in single elemental reduction/oxidation reactions. Therefore, the limit of the overall quantum efficiency, defined as the number of e^-/h^+ redox steps divided by the number of absorbed photons, amounts to 1. In an energy-downhill reaction, the energy evolved in the process can be dissipated as heat (and lost) or used to accelerate the next elemental or catalytic steps. Taking this into account, one can expect the overall quantum efficiency might exceed unity. To facilitate it, appropriate catalytic and redox conditions should be provided. The possibility of such reactions, including the design of appropriate catalytic/photocatalytic materials, will be illustrated and discussed.

2026.11.27 / 11:00 / NFTMC Saulėtekio al. 3 D401

Daugiau informacijos: https://sites.google.com/view/nftmc-emss/