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Approaches on Carbon Free Energy Source from Water Splitting

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Energy from sunlight is most plentiful renewable energy resource, on condition that earth with as much as necessary power that is proficient of taking care of all desires of living being. But that energy is not always usable to us for modern society. With rising population, modern scientific requirements and other development, there must be increase in energy demand day by day. Scientifically developed procedures that may use sunlight to split water into hydrogen and oxygen may be clue to solve this concern, since water splitting generates a perfect non-hazardous fuel and must be low in cost. Thus, it is critical to research for new and economical technologies for water splitting. Since 1970[1] research has been going on making suitable device for producing H_2 and O_2. With the on-going power of technology several economic effective strategies[2-5] have also been developed. Potency, cost value and longevity are the three major concerning factors during developing any new photochemical device. On the basis of these several approaches were made regarding this water splitting (WS) research.

One of the most convenient approaches in this field is plasmonic solar approach in which surface plasmons are the basic soldier for controlling the both functions viz electronic and optical.Recent research has revealed that when exposed to photons of Sun-like intensity, plasmonic photoexcited nanostructures, as opposed to metal structures, exhibit comparatively significant photocatalytic activity.[6] In silicon based WS devices light scattering[7] controls mode of operation. Different metal based photoelectrodes (Ni, Ag, Mo etc) were developed since few years.

During the solar WS reaction, semiconductor photo electrodes are involved in intricate chemical, physical, & electrical processes that operate the photogenerated electron-hole pairs for redox reactions.

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Three processes have been identified for the process by recent WS research: charge carrier synthesis in semiconductor photoelectrodes, charge carrier migration from bulk to surface, & redox reactions at surface reaction sites. Execution of photo electrochemical performance of nanostructured photoelectrodes has made substantial use of surface engineering techniques. Atomic layer deposition (ALD) is one of the most significant techniques for passivating surface states of semiconductor photo electrodes. As water oxidation & reduction occur at electrode-electrolyte interfaces, photo electrodes' extraordinarily high surface areas are crucial for boosting their effectiveness in WS. In order to improve photoelectrochemical performances, enhanced surface engineering that encompasses deposition of mono- or multilayer modifiers at semiconductor-electrolyte interface is essential. Number of novel interfaces emerge during surface modification, including semiconductor-modifier interface, modifier-electrolyte contact, & other interfaces between modifiers in neighbouring layers in event of multilayer modification.

Artificial photosynthesis is an inspirational pathway for WS,[18] The simplest configuration & dual combination of catalysts for solar & water electrolysis, OER & H2 evolution HER reaction, are used to create an artificial leaf. This configuration enables photovoltaic cells to be kept out of touch with water since it is in fact a significant problem for a solar cell's stability in water. The building is made more difficult by the wire-free artificial leaf's structure. To do this, the photovoltaic material & catalysts HER & OER must create a buried junction. It is difficult to find appropriate methods to stabilise the photovoltaic material in this situation since it must be submerged in water to function.[9]

The difference in energy between the photoelectrodes' valence band maximum and intrinsic oxidation potential controls how stable they are against oxidation.[10] A multi-property optimisation issue resulting from such a complicated interaction is difficult to resolve experimentally, in part because of difficulties with the structural characterisation of interfaces. Hence, strong tools for examining photoelectronic interfacial characteristics and completing experiments are provided by theoretical models and computational research. The capacity for regular modelling & simulation as predictive tool is growing quickly, & it is now first-principles approach to electronic structure computation in particular thanks to recent advancements in high-performance computing & advanced electronic structure theories & codes. But it must be minding that photoelectrochemical system optimisation requires careful consideration of both surface chemistry and semiconductor physics.[11,12] Also, the solar thermochemical pathway assures that it is an appropriate method for reaching this goal. Although the photovoltaic-powered electrolysis of water and artificial chemical reaction are intriguing strategies, their application is somewhat constrained by their poor solar-to-fuel conversion efficiency of 5% & 15%, respectively.[13] Availability of adequate solar reactors is crucial to WS's ability to use the solar thermal channel. Many publications have gone into great length on how to build a solar reactor that can operate a range of cycles, materials, and temperature systems.[14]

Nanostructures made of insulation and semiconductors provide a plethora of possibilities for influencing or regulating light at the nanoscale. Its interaction with incoming sunlight is stronger the greater their dielectric constant. When correctly scaled and structured, they can also display extremely potent optical resonances that, in comparison to bulk materials, can further encourage light-to-light/light-matter interactions. The fact that intensity of these resonances is comparable to that of metallic nanoparticles is significant.[15] They may also be found in deep-sub wave length structures (10 nm), & they have already improved performance of nanoscale opto electronic devices by allowing them to merge with identical-sized semiconductor electronic components. These renowned nanoparticle aggregates could be capable of exceeding theoretical boundaries in photon-to-current conversion. The gap between stated new benchmark & theoretical maximum efficiency may be closed if structural characteristics of these aggregates are better understood. For photoelectrochemical WS under 100 mW cm^2 air mass & 1.5 illumination, electrodes made with a lot of these protective nanostructures get the maximum photocurrent of any metal oxide photoanode.

Conclusion

WS, which uses solar energy and photocatalytic semiconductors to make renewable fuels from plentiful resources, is regarded as one of the most innovative and ecologically benign processes. For the half of reactions (either H_2 or O_2 generation) that utilise WS but are costly, hundreds of other semiconductors have been created and tested since the discovery of this technique. The whole WS community has set cost efficiency as a top priority. The necessity of using reliable, affordable, and effective solutions is undeniable for industrial applications. There is still a significant difficulty in the realm of creating a photocatalyst that satisfies these parameters for WS.

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