PROJECT TITLE: Green hydrogen production for clean environment.

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Project keywords: green hydrogen; solar energy; clean environment; nanomaterials; net zero

Proposed start date: Monday 3 June 2024

Project description:

Clean and sustainable energy and environment are grand challenges that the world is facing, and transportable and storable fuels (chemical fuel) from renewable resources can make a vital contribution to address these challenges. Chemical fuels such as hydrogen produced from renewable resources (water and sunlight) and chemicals such as methanol, ethanol, methane and syngas by reduction of CO_2 back to fuel can make solar energy highly distributable, from small to large scale applications. Currently most developed renewable energy sources are based on electricity generation or thermal energy and cannot fulfil the energy transportation and storage demand. Therefore, the conversion of ***solar energy or power into chemical fuels as a vital future energy carrier*** is the main challenge and its technical advancement is required to overcome this to provide clean energy to the world.

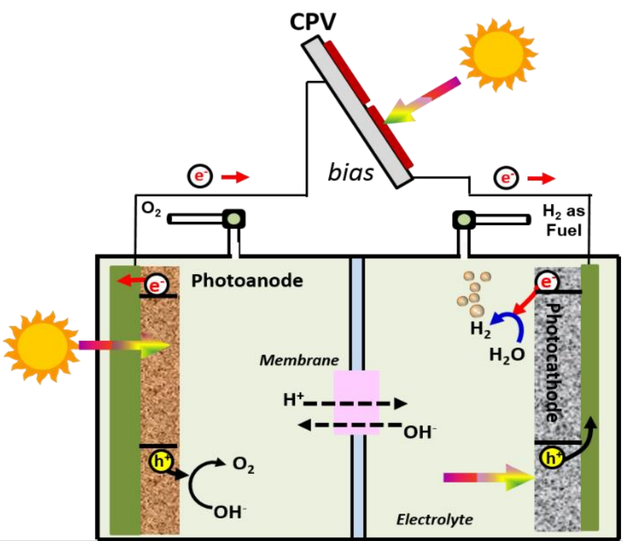

Fig.1 PV-AP tandem device for solar to chemical energy conversion

Solar energy can be captured and stored directly in the chemical bonds of a material, or 'fuel', and then used when needed. These chemical fuels, in which energy from the sun has deliberately been stored, are called solar fuels. Hydrogen (from solar water splitting) is an efficient energy carrier. If CO_2 reduction and H_2 could produce cost-efficiently in a sustainable manner, the world's energy needs could be met for a long time to come. Photoelectrochemical (PEC) water splitting / artificial photosynthesis is the best technology to produce H_2 cost effectively. However practical and scale up application, PEC need to overcome many challenges such as (i) lack of suitable and stable semiconductor materials, (ii) incompatible bandedge positions for spontaneous reaction, (iii) slow reaction kinetics and (iv) bias potential requirement. The applied bias requirement is one of the main challenges. The proposed PV-PEC tandem cells has advantages over PEC such as (a) the open-circuit potential is promoted by adding both energy level difference between n-photoanode and p-photocathode and (b) the nanostructured photocathode is not depends with electron reception from photoanode, it independently generate and receive required bias from PV to drive the photoreduction process. In this way we will overcome one of the major barrier which hinder the solar fuel generation. The other challenge in PV-PEC systems is development of infrastructure and robust industrial scale-up of advanced materials. Therefore, it is anticipated that increasing our understanding the materials properties, charge transfer at electrode/electrolyte interfaces, band gap engineering will enhance our efforts in hybrid solar cells driven solar fuel generation system.

Candidate requirements: Basic knowledge of chemistry, physics or nanotechnology.

Approximate Work Schedule in weeks:

desk based -2 weeks

lab-5 weeks

report writing-1 week