Cyanobacterial hydrogenase in photobiocatalytic H_2 production

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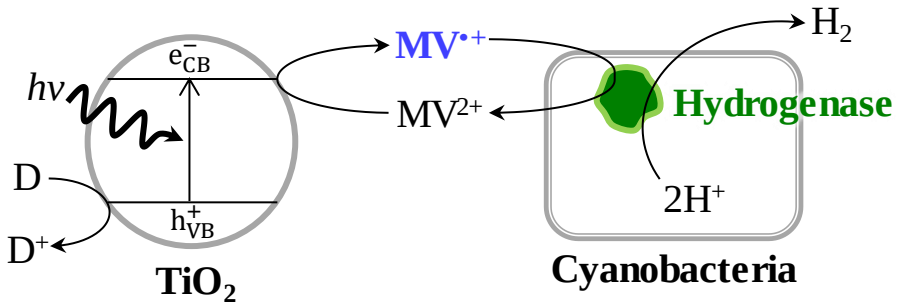
Solar to H_2 energy conversion is one of the most promising approaches of the future to replace finite fossil fuels, owing to its carbon-free, renewable and environment-friendly system. According to the objectives and research effort of Project 2-1 of our division during 2014-2020, we has been focusing on the optimization of photocatalysts and the application of hydrogenase for H_2 production. Photobiocatalysis has been attractive due to its flexibility, low energy cost, and eco-friendly characteristics. This work aims to discover and apply cyanobacteria and photocatalyst for photobiocatalytic H_2 production. *Anabaena variabilis*, a filamentous cyanobacteria, was cultivated in nitrogen-free Allen & Arnon medium to stimulate the differentiation of heterocyst. A novel application of TiO_2 coupled to the extracted protein of cyanobacterial cells significantly generated H_2 compared to TiO_2 alone. Inductively coupled plasma (ICP) technique reveals the existence of both NiFe-hydrogenase and FeMo-nitrogenase from the amounts of nickel (Ni) and molybdenum (Mo) atoms at their active site, respectively. Both biocatalytic enzymes show a crucial role for H_2 production. In addition, it was found that cyanobacteria can generate ammonia from N2 fixation in air through a function of nitrogenase enzyme. The achievement of this study is to provide an alternative technique to overcome a major obstacle of O_2 sensitivity that considerably necessary for low-cost application of industrial-scale H_2 production from renewable resource without CO_2 emission.



Scheme 1 Photobiocatalytic H_2 evolution from the combination of TiO_2 and hydrogenase-expressing cyanobacteria. D = an electron mediator, MV = methyl viologen.