Hydrogenase from cyanobacteria, a powerful biocatalyst, for future H2 production

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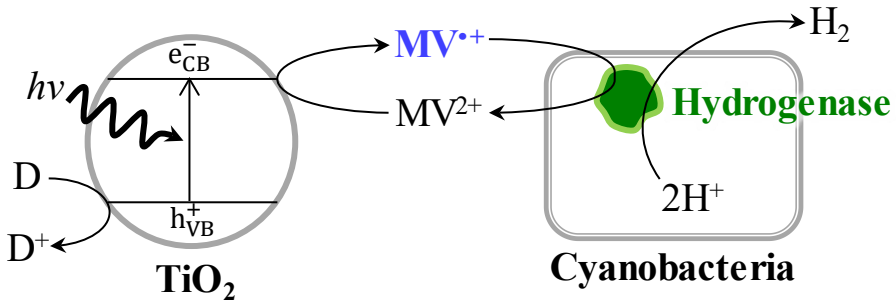
Solar to H_2 energy conversion is one of the most promising approaches of the future to replace finite fossil fuels, owing to its carbon-free, renewable and environment-friendly system. According to the objectives and research effort of Project 2-1 of our division during 2014-2020, we has been focusing 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 expressing bidirectional hydrogenase, 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 hydrogenase and nitrogenase in extracted protein fractions 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 under aerobic and anaerobic conditions. 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.