無機半導体光アノードと組換え大腸菌全細胞を用いたバイオカソードによる光電気化学的水素生産

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Photo-Electro-Biochemical Hydrogen Production from Water with Semiconductor Photocatalyst and Whole-Cell Biocatalyst of Recombinant *Escherichia coli* (*Faculty of Science, Nara Women's University*) Yuki Honda, ○Reina Hamakawa, Risa Yuki, Hiroshi Fujii

A new photoelectrochemical system was constructed for clean hydrogen production by solar water splitting, combining an inorganic photocatalyst-based photoanode with a biocathode system[1]. The biocathode system consists of a carbon paper electrode (CP), an electron mediator (MV^{2+}), and the whole cell of recombinant *Escherichia coli* expressing [FeFe]-hydrogenase genes (Hyd+). Carbon materials are not suitable for hydrogen-forming cathode due to their high overpotential for proton reduction; however, the combination of the reduction of an organic electron mediator on the CP electrode and the hydrogen formation with the reduced mediator by the hydrogenase provides a hydrogen-forming cathodic reaction comparable to that of the noble metal electrode. This study demonstrates that Hyd+ can be employed as a part of the hydrogen-forming biocathode system and that the biocathode system wired with TiO_2 photoanode can be a photoelectrochemical water splitting system without external voltage assistance under natural pH.
Keywords : Hydrogen Production; Hydrogenase; Photocatalyst; Water Splitting; Whole-Cell Reaction

太陽光での水の分解によるクリーンな水素生産に向けて、酸化チタン光アノードとバイオカソードを組み合わせた光電気化学的水素生産系を構築した[1]。ここでのバイオカソードはカーボン紙（CP）、電子伝達剤（MV）、[FeFe]-ヒドロゲナーゼを大量生産する組換え大腸菌細胞（Hyd+）で構成される。炭素材料は水素生成の過電圧が大きく通常は水素生成カソードには適さないが、CP 上での有機小分子である MV 還元と、還元された MV と酵素による水素生成を組み合わせて貴金属電極に匹敵する水素生成カソードが得られる。得られたバイオカソードと酸化チタン光アノードを組み合わせて、犠牲剤の添加や外部電圧の補助なしで光電気化学的な水素生産が確認された。

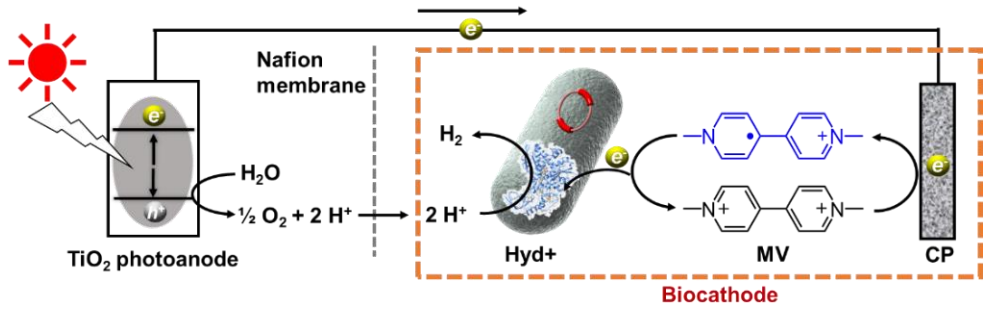

Fig. 1 Hydrogen production by a photo-electro-biochemical system combining TiO_2 photoanode with biocathode.

1) Y. Honda, R. Yuki, R. Hamakawa, H. Fujii, *ChemSusChem* **2024**, *17*, e202300958.