CO_2-hydrogenation into formate by the membrane-bound enzyme complex

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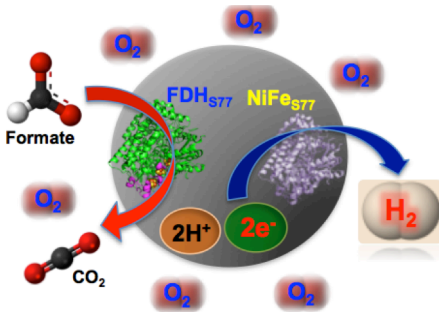
H_2 is an effective energy carrier with a high energy density per molecule. Therefore, we are particularly interest in the biochemical reaction of H_2-dependent reduction of CO_2 into formate, because formate is greenhouse gas sequestration and can easily store energy as a renewable liquid hydrogen energy carrier. However, most biocatalysts to perform CO_2-hydrogenation are highly O_2-sensitive, which is bottleneck for biotechnical application. To resolve this difficult issue, we have found a number of new O_2-stable [NiFe]hydrogenases and determined the structural basis for the catalytic mechanism of H_2 and O_2 molecules[1-3].

In this study, we constructed an efficient system for H_2-dependent CO_2 reduction into formate using the immobilized bacterial membrane on carbon black. Because a [Mo]-formate dehydrogenase (FDH_{S77}) and a [NiFe]-hydrogenase ($NiFe_{S77}$) from our isolated bacterium *Citrobacter* sp. S-77 displayed high catalytic activity with remarkable O_2-stability[4,5]. In fact, the fabricated polymer electrolyte fuel cell (PEFC) using the purified $NiFe_{S77}$ as an anode catalyst, displaying its power density over 647-times superior for H_2-oxidation than that of a platinum catalyst in the PEFC[6]. Intriguingly, our recent structural analysis revealed that an amino acid of Asp81 near a proximal [4Fe-4S] cluster plays a key role in its catalytic activity for H_2-oxidation and O_2-tolerance[7]. The immobilized FDH_{S77} and $NiFe_{S77}$ onto carbon black lead to elevate the reversible activity for H_2 production from formate and H_2-dependent CO_2 reduction into formate (**Scheme 1**). Notably, the H_2 production can occur even in the presence of air environment. To our future studies, we will construct a high efficiency biological system for CO_2-hydrogenation into formate by the homogeneously purified FDH_{S77} and $NiFe_{S77}$ immobilized onto carbon black. On the basis of our findings, I will present the structural and functional insights into the biochemical CO_2-hydrogenation into formate with robust biocatalysts for Carbon-Neutral Energy Research.



Scheme 1. Biochemical system for the reversible reaction of H_2-dependent CO_2 reduction into formate by an immobilized bacterial enzymes onto carbon black.

References worked by author;

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