Electrocatalytic Reduction of Low Concentration CO_2 by Iron Porphyrins

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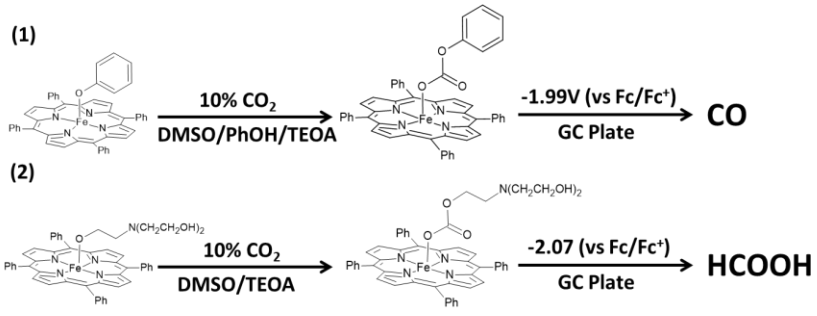
Keywords: Low Concentration CO_2 Reduction; Iron Porphyrin; Electrocatalytic reaction

Transition Metal Complexes are one of the effectively utilized systems for the selective conversion of CO_2 with high efficiency, and most of these catalyst systems can function effectively under electrochemical and photochemical conditions. For the practical realization of these systems for the direct conversion of CO_2 in the flue gas, the catalyst should work under low concentrations of CO_2.[1] The Re(I) complexes with a deprotonated triethanolamine are efficient catalysts for direct reduction of low-concentration CO_2; the versatility of this system is attributed to the fast CO_2 insertion reaction to the Re-O bond.[2] However, considering the elemental strategy, we should identify other efficient catalysts based on earth-abundant elements that can work under low CO_2 concentrations.

Porphyrin complexes of iron are efficient catalysts for CO_2 reduction under electrochemical and photochemical conditions. Selective electrochemical reduction of CO_2 to CO is observed in most iron porphyrin-based catalyst systems under pure CO_2 atmosphere when a Brønsted acid is employed as an additive or prepositioned near the catalyst by ligand modification.[3] In this report, we could successfully observe CO formation using the commercially available iron porphyrin catalyst Fe(III) tetraphenyl porphyrin (FeTPP), under 10% CO_2 concentration with a 91% faradic yield and 23 TON in the presence of phenol and TEOA (trace,) indicating the possibility phenyl carbonate formation with FeTPP-Phenol system (eq. 1). The formation of Fe-CO_2-OPh was confirmed using FTIR by observing the C=O stretching upon CO_2 bubbling to the FeTPP-OPh complex. Another aspect is the possibility of low-concentration CO_2 reduction in the presence of triethanolamine (TEOA); the reaction produced HCOOH as the major product with a 52% faradic yield and 12 TON, in this case also, the CO_2 inserted complex, Fe-CO_2TEOA was observed using FTIR (eq. 2).



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