Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information

Sustainable production of HCOOH *via* an electrolytic reduction of gas-phase CO_2

Seunghwa Lee, HyungKuk Ju, Revocatus Machunda, Sunghyun Uhm, Jae Kwang Lee, Hye Jin Lee and Jaeyoung Lee

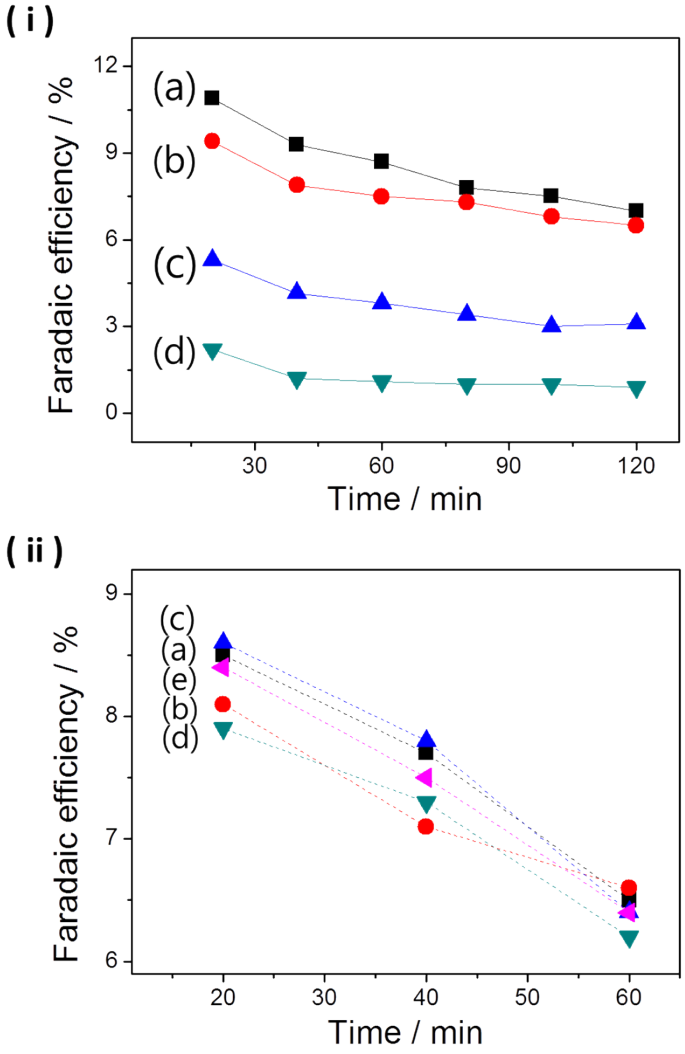


Figure S1. (i) Faradaic efficiencies depending on the various operating temperatures : (a) 30°C (b) 50°C (c) 70°C (d) and 100°C. (ii) Faradaic efficiencies depending on the various hydrogen gas flow rates : (a) 20 ml min^{-1} (b) 40 ml min^{-1} (c) 60 ml min^{-1} (d) 80 ml min^{-1} and (e) 100 ml min^{-1}. Ambient operating room temperature (30°C) showed the higher faradaic efficiency and was maintained during long-term CO_2 electroreduction. There was no relationship between hydrogen suppy and mass transfer limitation relative to the catalytic activity.

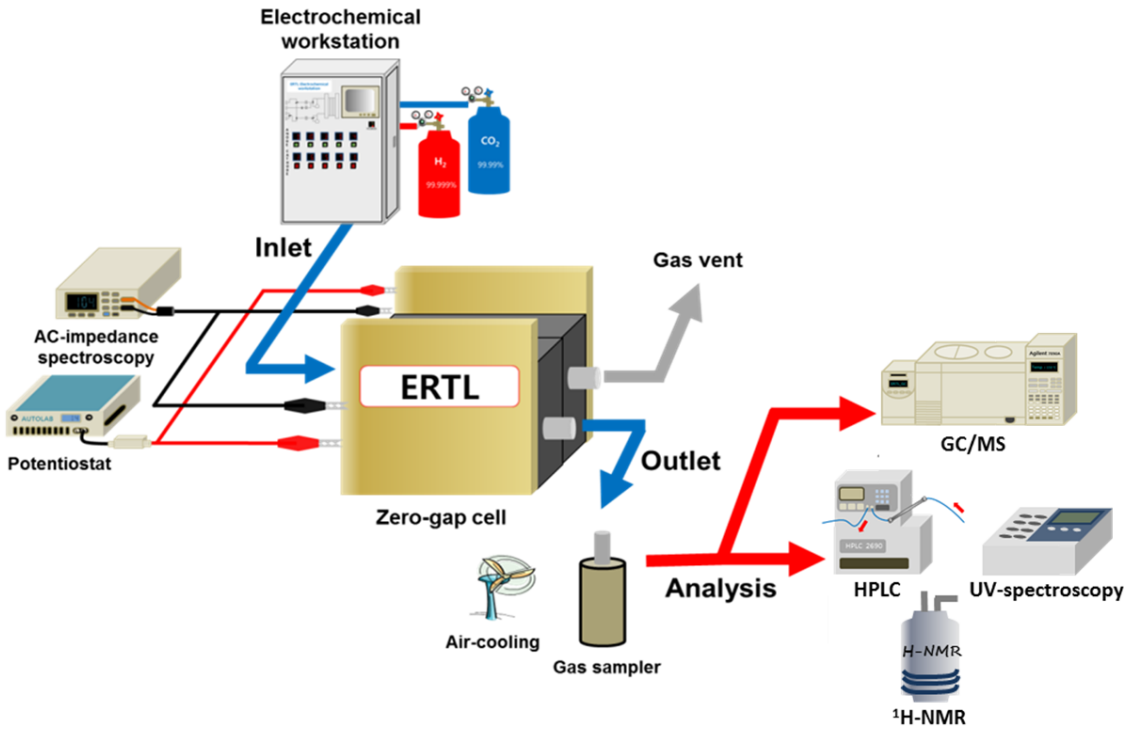


Figure S2. Schematic diagram of the configuration for CO_2 electroreduction system including the analysis equipment.

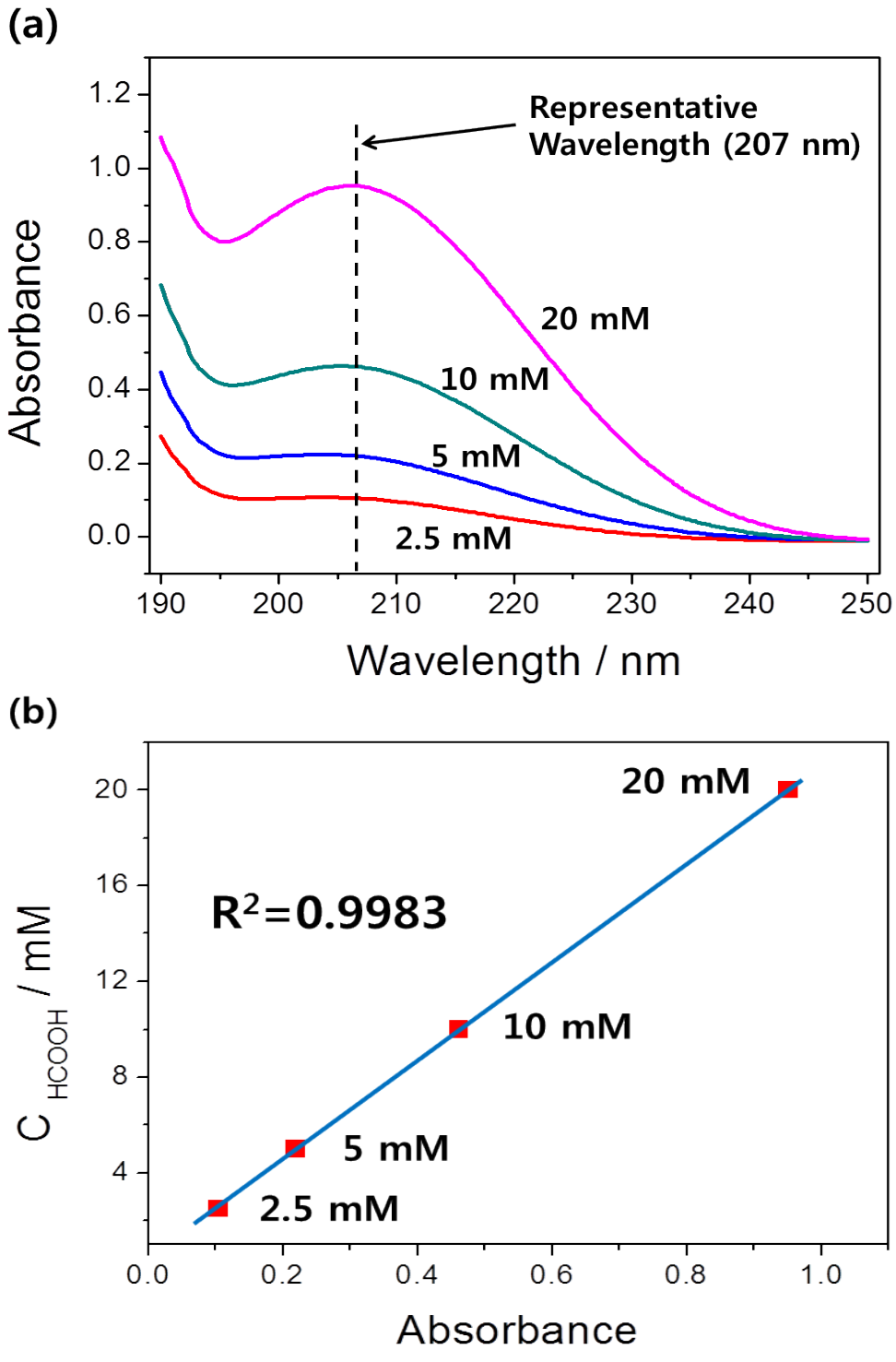
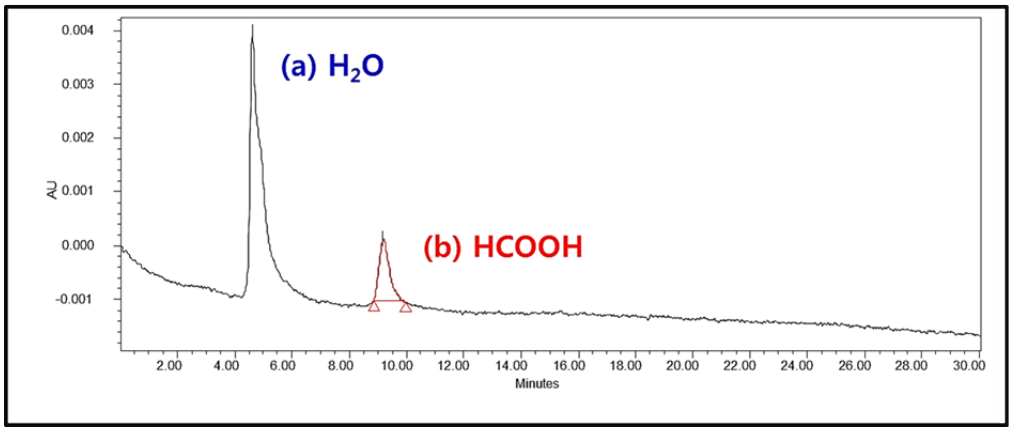


Figure S3. Quantification procedure of formic acid by UV-spectroscopy, UV-Vis absorption spectra for different concentrations of commercial formic acid (a) and calibration curve from (a) for measurement of HCOOH generated by CO_2 electroreduction (b).

(i)



(ii)

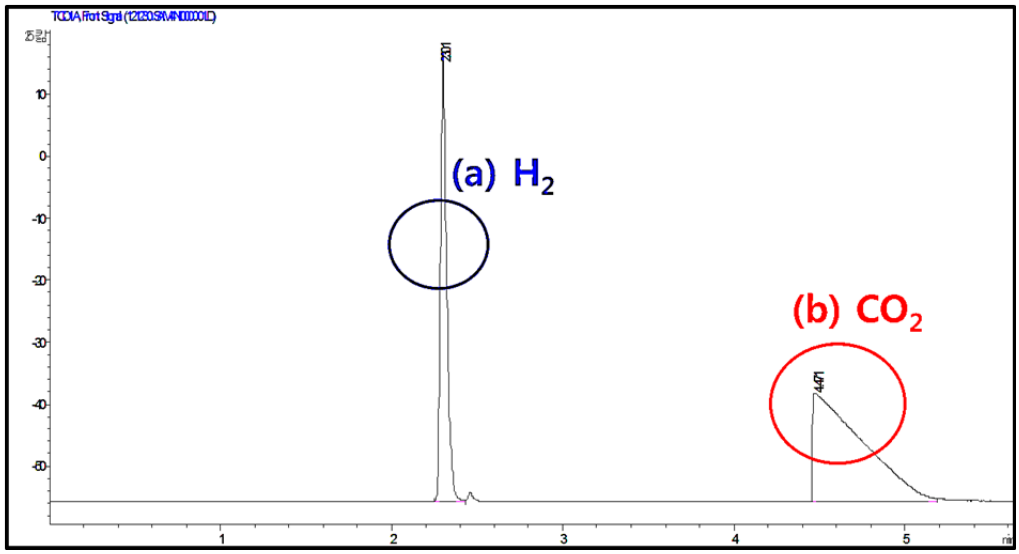


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Figure S4. (i) HPLC product analysis results of liquid phase samples generated from electrochemical CO_2 reduction. H_2O (a) and HCOOH (b) were observed with retention time of 4.86 and 9.19 respectively. (ii) Separation by GC-TCD detector at oven temperature of 35°C. H_2 (a) and unreacted CO_2 (b) were observed with retention time of 2.3 and 4.45 respectively.

Table 1. The weight of cathode electrodes before and after CO_2 electroreduction of 1 h, 2 h and 5 h respectively.

	Before (mg)	After (mg)	Amount of Sn particle loss (mg)	Operating Time (h)
Sample 1	147.3	145	2.3	1
Sample 2	144.1	139.4	4.7	2
Sample 3	145.5	137.2	8.3	5