Supplementary information

Minimization of Pt-electrocatalyst deactivation in CO_2 reduction using polymer electrolyte cell

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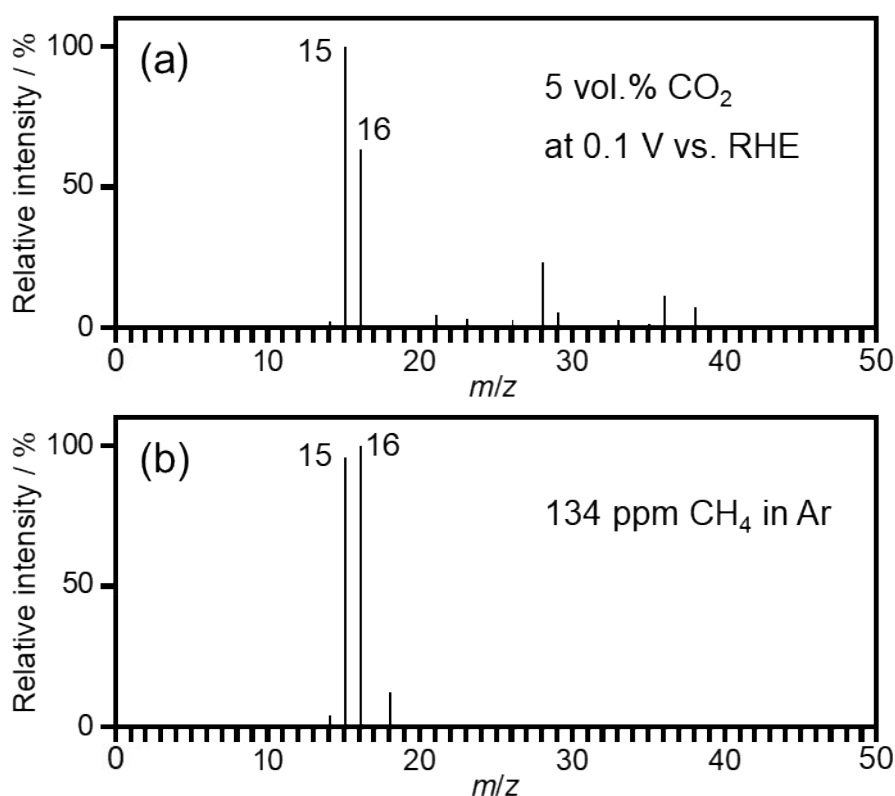
Fig. S1. Mass spectra of (a) the WE exhaust gas from CO_2 reduction at 5 vol.% CO_2 and (b) CH_4 gas (purity: 99.999%) diluted with Ar.
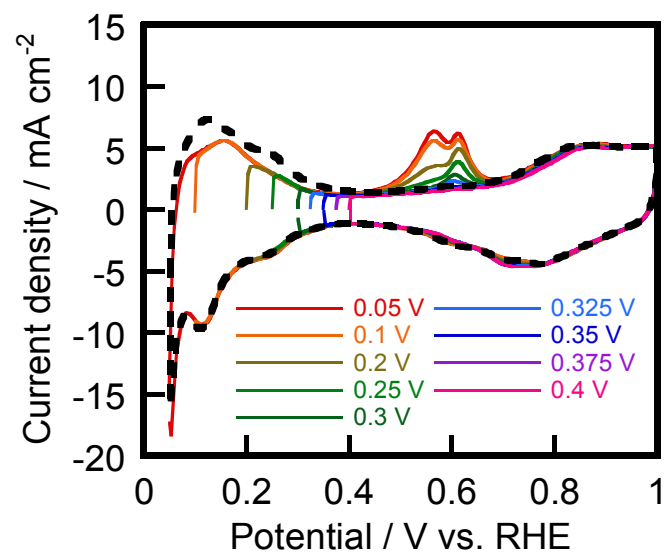
Fig. S2. Cyclic voltammograms of Pt/C electrocatalyst at each 5-min initial hold potential at the CO_2 concentration of 4 vol.%. Scan rate was 10 mV/s.
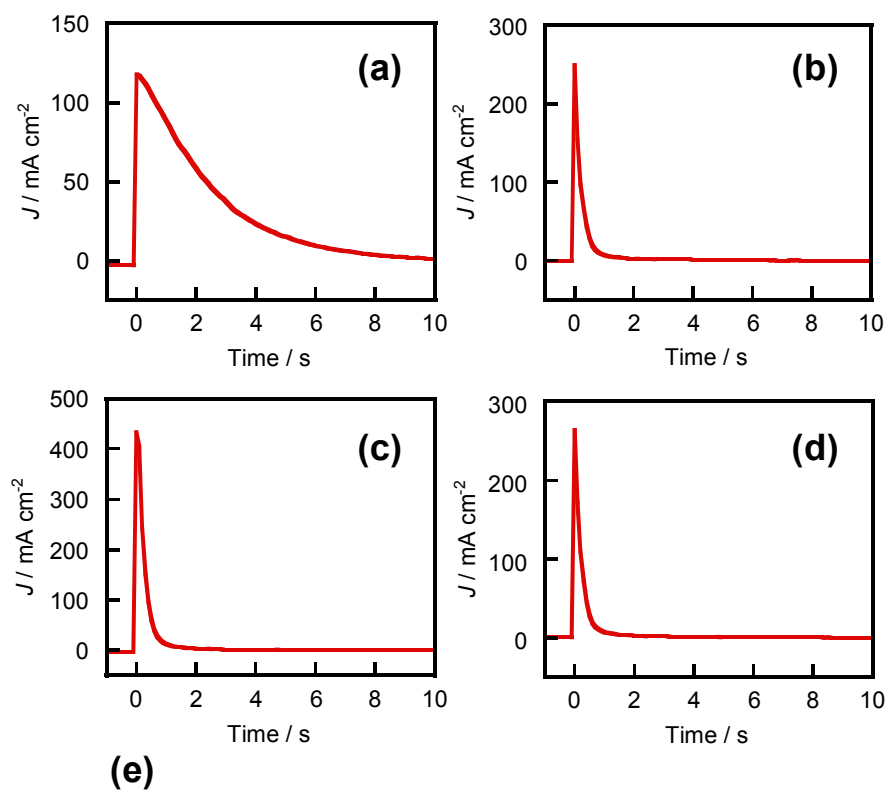
Fig. S3. (a-d) Current responses by potential step and (e) the molar Pt-CO/Pt-H ratio after the operation displayed in Fig. 7(c) and Fig. 5(b). To consider why the recovery for the potential-sweep method is as high as 86.0% (Fig. 7(c)), we evaluated the formation ratio of Pt-CO/Pt-H after the operation displayed in Fig. 7(c). After the deactivation operation presented in Fig. 5(b), the potential was swept on the anodic side up to 0.3 V and subsequently returned on the cathodic side to 0.2 V. Afterwards, the potential was stepped to 0.7 V in (a) and to 0.7 V via the potential step to 0.35 V (b). Hence, the coulombic charges of both H and CO desorption (Q_H and Q_{CO}) can be determined from the observed oxidation current in (a), and the Q_{CO} can be determined from the oxidation currents in (b). The Q_H can also be calculated by {(Q obtained from (a)) − (Q obtained from (b))}. As a result, the Pt-CO/Pt-H ratio formed on the catalyst surface, which was calculated by taking into account the number of electrons for each oxidation reaction, was determined as 1:17. Therefore, the Pt-CO/Pt-H ratio was

restored up to 1:17 after the recovery operation of potential sweep presented in Fig. 7(c). Here, when the potential was stepped to 0.7 V in (c) and to 0.7 V via the potential step to 0.35 V in (d) soon after the deactivation operation displayed in Fig. 5(b), the Pt-CO/Pt-H ratio was determined as 1:2.2. Overall, the method provided in Fig. 7(c) would be energy saving and effective to regenerate CH_4 production because the Pt-CO and Pt-H ratio in Fig. 7(c) shows a value close to the initial ratio of 1:18 (presented by Fig. 5(a)).