Production of Carbon Monoxide in One-Chamber Reactor Using Boron-Doped Diamond Electrodes

Yuki Shimizu
Andrea Fiorani, Yasuaki Einaga
Department of Chemistry, Keio University, 3-14-1 Hiyoshi, Yokohama 223-8522, Japan.
y.shimizu521@keio.jp

Carbon monoxide (CO) production by electrochemical reduction of carbon dioxide (CO_2) is a highly valuable process because CO has various industrial applications.[1][2] Boron-Doped Diamond (BDD) is known as a highly stabile and suitable electrode for CO_2 reduction.[2] Conventionally, two-chamber flow reactors using BDD as working electrode have been used for CO_2 reduction to CO. Anode and cathode of two-chamber flow reactors are separated by an ion-exchange membrane, where two aqueous electrolytes flow into the anode and cathode chamber, respectively.[2] However, there are concerns about the durability and cost of the ion-exchange membrane, moreover the system is larger and more complex. Therefore, we evaluated the suitability of one-chamber flow reactor for producing CO, which does not require an ion-exchange membrane, and optimized the conditions that maximize the Faradaic efficiency for CO production. First, we optimized the reduction potential in one-chamber flow reactor, and the highest Faradaic efficiency (FE) for producing CO was 51.7% at −1.9 V. This was also superior to the results in the two-chamber flow reactor at the same potential (Figure 1). Next, the comparison of different counter electrode materials showed that the highest FE for producing CO was 57.8% when IrO_2 was used (Figure 2). If BDD was used as counter electrode, it showed the most positive potential; in addition, decreasing FE for CO implies that CO produced at the BDD working electrode can be oxidized on the BDD counter electrode. Finally, electrolyte investigation showed the highest FE for producing CO with 0.1 M $KClO_4$ aqueous solution. The best conditions for CO production in one-chamber flow reactor are: applied potential −1.9 V, in combination with IrO_2 counter electrode and 0.1 M $KClO_4$ aqueous electrolyte.

References

[1] D. U. Nielsen, X. M. Hu, K. Daasbjerg, T. Skrydstrup, *Nat. Catal.*, 1 (**2018**), 244
[2] J. Du, A. Fiorani, Y. Einaga, *Diam. Relat. Mater.*, 135 (**2023**), 109902

Figures

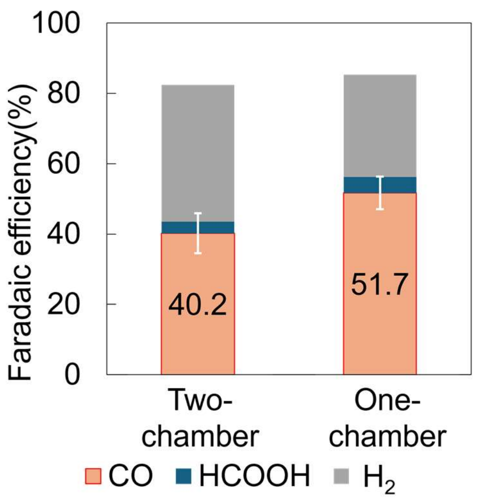

Figure 1: Faradaic efficiency compared with one-chamber flow reactor and two-chamber

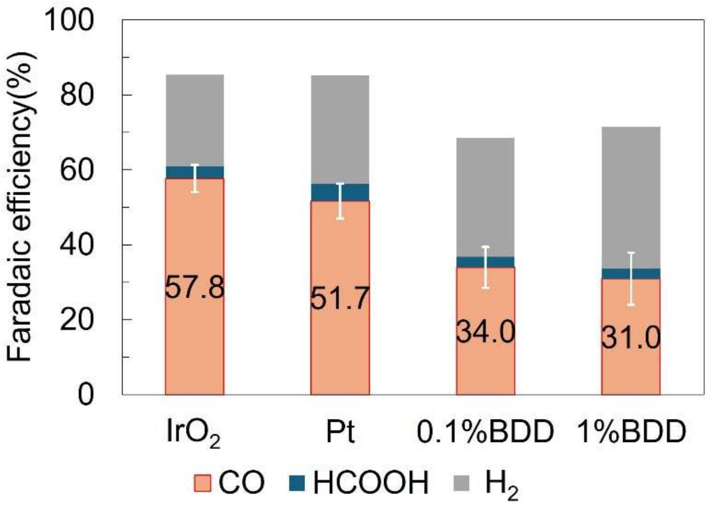

Figure 2: Faradaic efficiency of using each counter electrodes