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Electrochemical reduction of $KHCO_3$ and $NaHCO_3$ using Cu electrode for the energy conversion and storage

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Electrochemical reduction of CO_2 into useful organics, especially to the combustible chemical fuels, is a good way to convert and store the solar energy because large amounts of the solar energy are converted into electricity through photovoltaic (PV) panels. Currently, most of the researches related to the electrochemical reduction of CO_2 use the gaseous CO_2 bubbling as the carbon source. However, during this process, most of the CO_2 is exhausted directly into the air without any reaction, which not only causes a waste of the carbon source but also makes the separation of the gas products and the unreacted CO_2 inevitable. Therefore, in this research, the carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) solution were used as the carbon source and their effect were studied and compared with the CO_2 bubbling.

In this research, A copper wire (φ0.5mm, 99.999%, Nilaco) was used as the working electrode. An Ag/AgCl electrode saturated with NaCl was selected as the reference electrode along with a Pt wire as the counter electrode. The CO_2 (99.995%, Taiyo Nippon Sanso) was bubbling for 10 min before and during the experiments when the CO_2 was used as the carbon source.

Results from the cyclic-voltammetric measurement showed that the CO_2 bubbling didn't affect the reaction too much when $KHCO_3$ were used as the electrolyte (Fig. 1). The onset potentials at, for example, -0.2 mA cm^{-2} were around -1.07 V *vs.* Ag/AgCl no matter with or without CO_2 bubbling. This is probably due to the dissolved CO_2 changed to HCO_3^- in this pH region. Hori and co-workers reported that the production of CH_4 and C_2H_4 increased steeply with the cathodic potential from -1.4 to -1.6 V *vs.* Ag/AgCl, while the H_2 generation dropped quickly in the electrochemical reduction of CO_2 in $KHCO_3$ electrolyte with CO_2 bubbling [1]. The Voltammogram obtained in the present research was very similar to the Hori's data. However, When the KCl or K_2CO_3 were used as the electrolyte, not only the onset potential shifted positively, but also the current changed obviously with the CO_2 bubbling. According to the pH value of the KCl electrolyte, the dissolved CO_2 became H_2CO_3, while in the K_2CO_3 solution, most dissolved CO_2 changed to CO_3^{2-}. Therefore, the HCO_3^- has an important role in the CO_2 reduction.

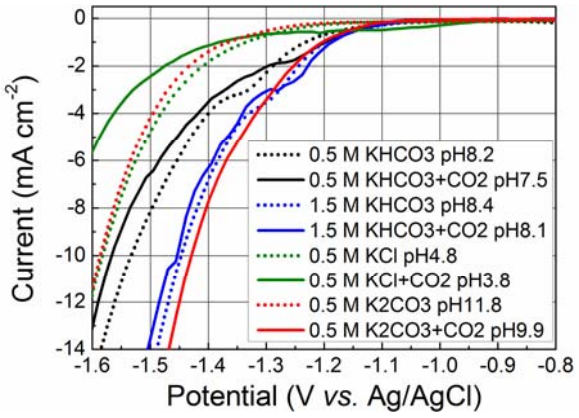

Fig. 1 Voltammograms obtained at different electrolytes with or without CO_2 bubbling (M: mol L^{-1}).

Reference

[1] Y. Hori, et al., *J. Chem. Soc., Faraday Trans. 1*, 1989, **85**, 2309.

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