Tohoku Univ. Technology

Electrochemical CO_2 reduction method

High-efficiency CO_2 electroreduction under hydrothermal conditions

Overview

The electrochemical CO_2 reduction reaction (CO2RR) process, in which CO_2 is electrochemically converted, is attracting attention as a promising CO_2 reduction method. However, the conventional method has a problem of low energy efficiency. The inventor has found that it is possible to improve the efficiency of the CO2RR process by utilizing a high-temperature high-pressure water environment called a hydrothermal conditions. When electrolysis is carried out in high-temperature high-pressure water at 150℃ and 100 atm pressurized with CO_2, the high diffusion coefficient and solubility of CO_2 in the water facilitating efficient CO_2 supply to the electrode, and the energy efficiency is significantly enhanced.

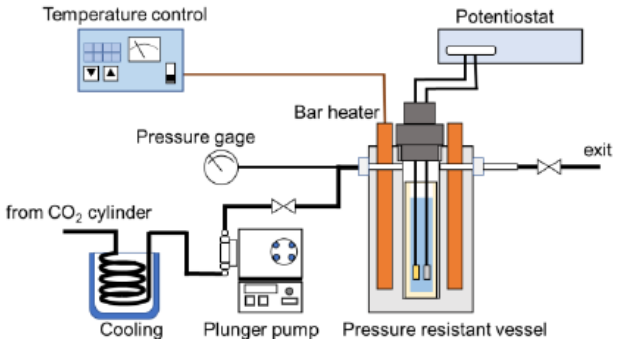
Additional assessment has shown that it is possible to synthesize "carbon-negative" basic chemical product (methanol), in which the amount of CO_2 absorbed exceeds the amount of CO_2 emitted, by leveraging low-temperature waste heat from industrial sources and renewable electricity.

Product Application

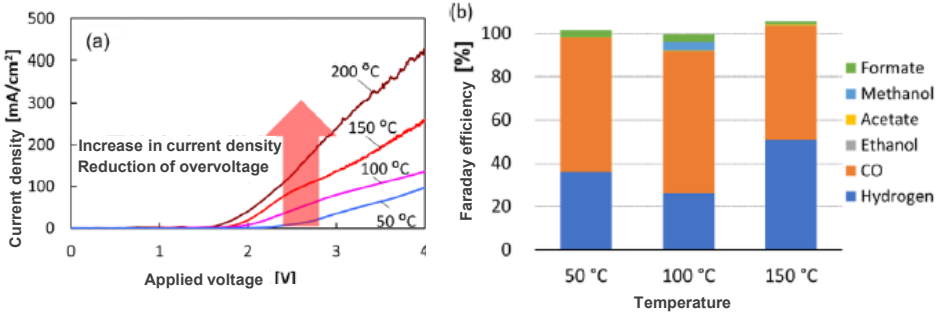
- High-efficiency CO_2 electroreduction using flue gas and low-temperature waste heat from factories, power plants, and waste-to-energy plants

IP Data

IP No.	:	PCT/JP2025/009449
Inventor	:	TOMAI Takaaki
Admin No.	:	T23-091



Effect of hydrothermal conditions on current density and products [1]



(a) Current density as a function of the applied voltage at various temperatures at 10MPa.

(b) Faraday efficiency (FE) for each compound produced by the cathodic reduction at ≈100 mA cm^{-2} under hydrothermal conditions (50–150 °C at 10 MPa).

Increasing the temperature enhances current density and enables the reaction to occur at a lower applied voltage, leading to improved energy efficiency.

Related Works

[1] Advanced Sustainable Systems, 2024, 2400489
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Contact

Tohoku Techno Arch Co., Ltd.
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