Abstract

[Research Title]

Development of highly effective CO_2 conversion by the electromagnetic-wave assisted chemical process using spinel catalysts with ultra-high specific surface area

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[Abstract]

This study aims to establish a fundamental technology for CO_2 catalytic reduction using reduced metal oxides, which is a key technology for carbon recycling. This study focuses on the seed technology for CO_2 reduction and aims to achieve high energy conversion efficiency while maintaining a high process speed to handle large amounts of CO_2 resources. To achieve these objectives, this study investigates the reaction mechanism and utilizes microwave chemistry to increase energy conversion efficiency. The ultra-high specific surface area of spinel materials can also be used to increase the contact area with the gas phase and improve the efficiency of the process.

Sub-Theme 1 focused on the efficient conversion of CO_2 using microwave chemical processes, whereas Sub-Theme 2 aimed to create spinels with ultra-high specific surface areas for the same processes. Sub-Theme 1 examined the CO_2 reduction performance of the materials developed in Sub-Theme 2 and used feedback for material development to maximize the CO_2 reduction reaction. Various studies were conducted such as verifying the CO_2 catalytic reduction process using $NiMn_2O_4$ nanospinel catalysts, elucidating the mechanism of the efficient CO_2 catalytic reduction reaction using ultra high specific surface area $NiMn_2O_4$ nanoparticles, using $ZnMn_2O_4$, $CoMn_2O_4$ and $MgMn_2O_4$ by compositional tuning. Through studies of Sub-Themes 1 and 2, the process achieved a lower temperature of 500 °C and a 50% speedup of the cycle compared to the initial targets of 200 °C or lower and a 30% speedup of the process cycle. The temperature range of the process was lower than the initially targeted range, and the temperature range where the unused waste heat could be utilized was reached.

[References]

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