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Production of Methane by a Contact of Carbon Dioxide with Hydrogen Plasma

水素プラズマと二酸化炭素の接触によるメタンの生成

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1. Introduction

Reduction of carbon dioxide emission in the environment is a crucial subject that must be settled urgently. Carbon dioxide, one of man-made greenhouse gases, has been thought as a cause of global warming.

In this study, conversion of carbon dioxide to methane was investigated by employing reactions of CO_2 with hydrogen radicals. The purpose of this study is to clarify fundamental process of reduction of carbon dioxide to generate beneficial and reusable organic materials like methane and methanol by using low-pressure discharges.

2. Experimental Methods

Here, three kinds of experiments were carried out and compared. The first one was a case of discharge with mixed gas of carbon dioxide and hydrogen, where CO_2 and H_2 were reacted in the same plasma space. The second one was a case that generation of methane was separated from a discharge of H_2 for preventing further decomposition of methane, where ratios of CO_2 decomposition and CH_4 selectivity were examined by changing discharge parameters such as gas flow rate and applied voltage. In the third case, magnetic field was applied, perpendicular to the electric field for the discharge, with mixed gas of carbon dioxide and hydrogen, where the effect of magnetic field on the conversion of CO_2 to CH_4 was investigated.

FTIR was employed to analyze the gas species before and after the discharge.

3. Experimental Results

From FTIR spectrum showing a change of gas species before and after the discharge, we could really observe decomposition of CO_2, together with simultaneous production of CH_4 and CO. Steam (H_2O) was also observed. Here, the results were arranged by defining decomposition ratio of CO_2 as α(%), methane selectivity as β(%), and energy efficiency of methane production as γ(L/kWh). Figure 1 shows variations of α, β, $\alpha\times\beta$, and γ in the cases of the first and third experiments. It was found that application of magnetic field improved all the values of α, β, $\alpha\times\beta$, and γ. The energy efficiency in particular increased to double.

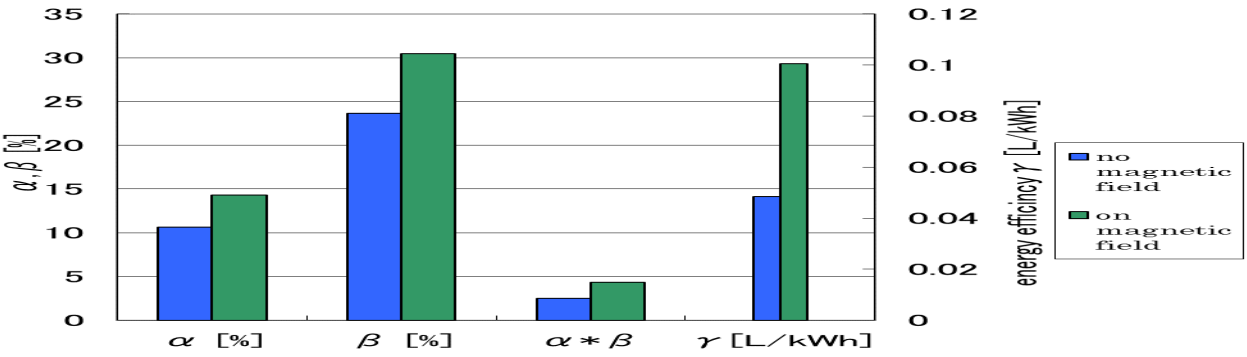

Fig.1 Effect of magnetic field

4. Conclusions

Owing to the effect of magnetic field, all the values of CO_2 decomposition, CH_4 methane, and energy efficiency for CH_4 production were improved. Application of magnetic field was crucial for the conversion of CO_2 to CH_4 in the low-pressure discharge.