Development of System for Hydrogen Production with Microwave Heating

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INTRODUCTION

There have a lot of processes that turning methane into hydrogen. For example, steam reforming of methane is a major process all over the world. Steam reforming of methane discharges CO_2. Since we dislike the gas because of greenhouse gas, we developed a new process [1]. This reaction of this process is as follows.

$CH_4 \rightarrow C + 2H_2 \quad \Delta H^0 = +76$ [kJ/mol]

A new process is used a catalyst and microwave heating. The catalyst is Ni-Mo_2C-HZSM-5 as the methane decomposition components and SiC as the matter to absorb microwave [2-3]. This new process does not discharge CO_2 in contravention of steam reforming of methane. The process is able to produce high purity and long-life hydrogen.

In this paper, we consider the method of heating (microwave and electrical furnace heating).

EXPERIMENT

Firstly, we made catalyst and stacked it into the reaction tube. The catalyst preparation was carried out the simple way with physical mixed commercial reagent powder.

Table 1 Catalyst composition

Functional Classification	Ingredient	Weight Ratio /wt%
Microwave-absorbing substance	SiC	30.0
Catalyst	HZSM-5	48.0
	Ni	20.0
	Mo_2C	2.0

Secondly, we introduced methane into a reactor and examined catalytic activity using on an electric furnace. Similarly, we examined catalytic activity using on a microwave. Finally, we analyzed catalyst by gas chromatograph, transmission electron microscope and Raman spectrometer.

RESULTS AND DISCUSSIONS

Fig. 1 shows the result of H_2 yields using on a microwave and an electric furnace.

In Fig. 1, the catalytic performance of H_2 yield using an electric furnace is decreased with reaction time. In particularly, H_2 yield on 100 min. become less than 10 %.

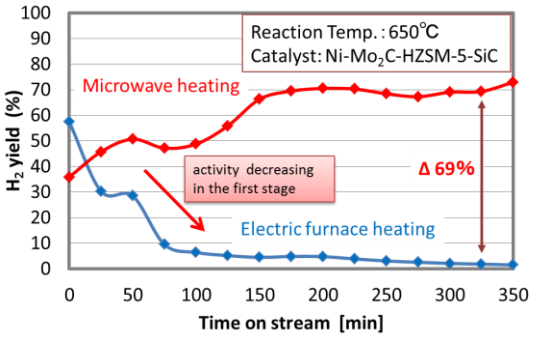

Fig. 1 Performance of catalyst using on the electric furnace and microwave (Reaction temp.: 923 K, CH_4-S.V.:110.7 hr^{-1}.)

In addition, we found that the generated carbon is a special one shaped like a section of an onion by TEM image. Moreover, it is a multilayer graphene.

Fig. 2 Schematic Image of methane decomposition with microwave heating and conventional heating

In Fig. 2, the electric furnace heating, coke deposition occurs because methane is reacted at catalyst activity sites (an acid center on HZSM-5). On the other hand, the microwave heating, the generated carbon can be laminated around the Ni particle (catalyst active species). Coke deposition does not occur in the case of microwave heating.

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