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Characterization of zeolite particles as internals of packed bed plasma reactor

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Keywords: Plasma, Hydrogen, Zeolite Input power

1. Introduction

The bottleneck of realizing a H_2 energy society is energy loss in the transportation and storage of H_2. In order to reduce energy loss, a new energy system using energy carriers has been proposed. NH_3 has some advantages as energy career and is attracted a lot of attention and is studied and developed conversion method to H_2 actively all over the world. Nowadays, a thermal decomposition method with a catalyst such as nickel or ruthenium is common as dehydrogenation method from NH_3. However, unreacted NH_3 contaminate in the H_2 gas generated from NH_3 pyrolysis. We have developed a plasma membrane reactor (PMR) that can simultaneously perform hydrogen purification and decomposition of unreacted ammonia. As a result of recent research, it was found that hydrogen purification performance is improved by filling a plasma membrane reactor with a dielectric. The purpose of this research is to elucidate the improvement mechanism of hydrogen purification performance when PMR is filled with dielectric. In this paper, the discharge characteristics of the PMR filled with a dielectric were examined by measuring the input power by the V-Q Lissajous figure in Ar plasma firing.

2. Experimental

The experimental equipment is shown in Fig. 1. Fig. 1 is constituted by the sample gas supply system, the high-voltage pulse power supply and the plasma membrane reactor (PMR). Further, The PMR is constituted by the hydrogen separation membrane module which doubles as the high-voltage electrode and the quartz tube (outer diameter 38 mm, thickness 2 mm, length 400 mm). The hydrogen separation membrane is made from the Pd – 40 wt%Cu (Nippon Seisen Co., Ltd.). SUS mesh is used as a ground electrode and the length is 300 mm. The gap length between the quartz tube and the high

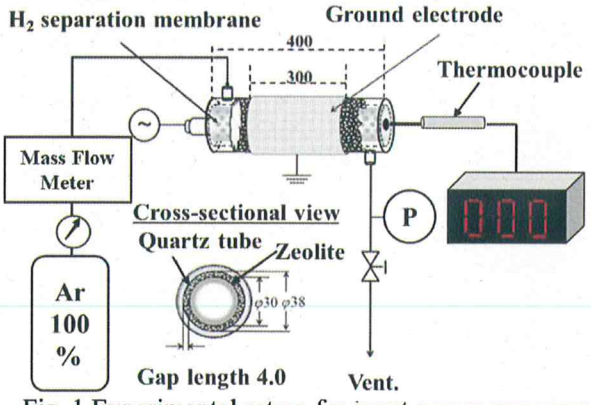

Fig. 1 Experimental set up for input power measurement.

voltage electrode is 4.0 mm. The high-voltage pulse power supply is made of Sawafuji Electric Co., Ltd. 8 capacitors (3300 pF, Murata Manufacturing Co, Ltd.) are used for measuring the V-Q Lissajous figure. Plasma occurs in the gap. Ar was used as a sample gas. Flow rate was controlled by the mass flow meter (ALICAT MS series). In addition, those measurements were performed by PMR with or without zeolite (X-type zeolite SA-600A; Tosoh Corporation).

3. Experimental results and considerations.

Fig. 2 shows the V-Q Lissajous figure of the PMR with or without zeolite (SA-600A). Lissajous figure takes a parallelogram in a normal dielectric barrier discharge. The results of PMR with zeolite approximate the Lissajous figure of the DBD discharge than without zeolite. From fig. 2, it considered that filling the zeolite improve stabilization of the internal electric field.

Fig. 3 shows the input power when the Ar gas is flowed. Blank was higher input power than SA-600A under 4.5 kV, 6.0 kV, but SA-600A is higher than Blank under 8.0 kV. In addition, the voltage that the plasma started to light was smaller than Blank of SA-600A.

It has been reported that polarization between dielectrics occurs when plasma discharge is performed in a dielectric filled plasma reactor. As a result, the electric field strength of the narrow gap between the dielectrics is greatly increased. More Ar was excited to plasma state by the high field intensity between dielectrics in a short time. In the PMR filled with zeolite, it is considered that plasma discharge was also uniformly fired due to increase in field intensity.

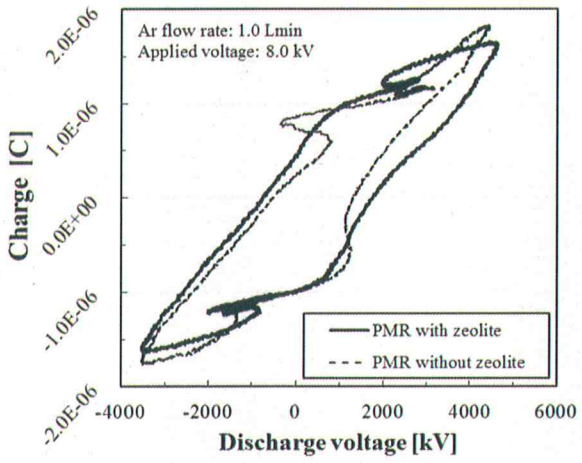

Fig. 2 V-Q Lissajous figures for Ar plasma firing by the PMR.

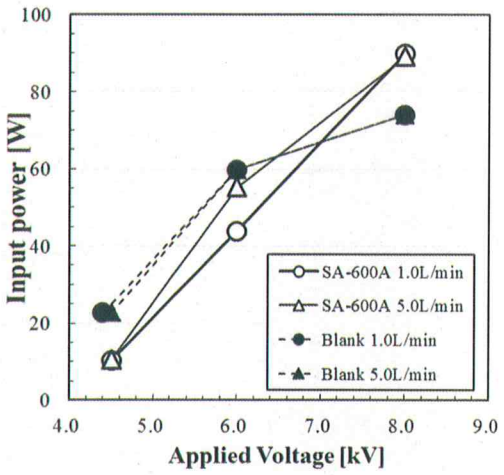

Fig. 3 The comparison on input power between the PMR with or without zeolite.

4. References

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