Fabrication of Si-N Based Microporous Membrane for High Temperature Hydrogen Separation

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Abstract

Porous ceramic filters are used in many processes of chemical engineering, because ceramic filters are superior to others in thermal, chemical and mechanical stability, high flux and accuracy. From 80's, nanoporous ceramic materials for gas separation have been studied, and the most important application recently under investigation is for hydrogen separation. Hydrogen is regarded as the new generation energy carrier with potential to solve growing problems of carbon dioxide emissions as well as overall energy supply. Hydrogen is mainly made by steam reforming of methane at 600~800^{o}C, at around 1.0MPa. It is well known that the efficiency of this reaction could be improved by selectively separating hydrogen out of the reactor using membranes. It is important that such membranes have high stability and hydrogen permeability. Based on this back ground, attempts were made to fabricate Si-N based hydrogen separation membrane.

Ceramic membranes are supported by porous ceramic substrates. We made porous silicon nitride (pore diameter: 0.1 μm) tubes as substrates. Polysilazane which is one of the precursors of silicon nitride was chosen as the precursor for membrane. By using polysilazane as the precursor for membranes, the thermal mismatch between the silicon nitride substrate and the membrane can be controlled. Therefore, a membrane with high heat-shock resistance, thermal and mechanical stability could accomplish.

The processing of membranes was carried out by controlling the pyrolysis of polysilazane. Using special treatments, we have produced membranes with large surface area (about 200m^2/g). The average pore diameter of this membrane was 0.5nm, with a narrow pore size distribution. The results of hydrogen/nitrogen permeation tests showed the separation factor over 100.

These membranes were mainly developed for applications in steam reforming. It is expected that the incorporation of the membranes will improve the system efficiency of fuel cell. Moreover, we expect that this high performance membrane could be applied for many other kinds of membrane reactors as well as other areas of chemical engineering.

Biographical Sketch

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Keita Miyajima received his master degree in 2001 in department of inorganic materials at Tokyo Institute of Technology. He is currently a member of the Research and Development Center, Noritake Co., Limited.

His research is focused on development of Si-N based gas separation membrane.