CH_4 at 850°C over an optimum 10Ni-0.9Re/$Ce_{0.5}Zr_{0.5}O_2$/Al_2O_3catalyst the H_2yield of 70% is attained.The designed catalyst has an enhancedstabilityagainst oxidation and sintering of Ni active component as well as a high resistanceto coking.

6. Hydrogen Production Systems I:

6.1 Design and Evaluation of Hydrogen Production Using Rh Supported Membrane Reactor (Edward Gobina, Habiba Shehu, Edidion Okon and Ifeyinwa Orakwe)

With the scale of oil, gas and petrochemical industries today, the use of a catalytic membrane reactor to make fuels from natural gas and carbon dioxide instead of exploiting crude oil will have a significant impact on the whole hydrocarbon chain value and produce a much cleaner society. In this research, methane and carbon dioxide were used as feed gas in the process of dry reforming using a laboratory scale catalytic membrane reactor to produce hydrogen and carbon monoxide that can present the starting point for methanol or ammonia synthesis and Fischer-Tropsch reactions. 0.5 wt% Rh catalyst was deposited on an α-alumina support and used to determine the reaction order and rate of CO_2 conversion at different gas hourly space velocities. The results showed the reaction obeyed the first-order kinetics and the conversion rates increased with increasing gas hourly space velocities.

6.2 Hydrogen Production System Using a Plasma Membrane Reactor (Yukio Hayakawa, Kota Shizuya, Shintaro Wakazono Kenya Tokunaga, Shinji Kambara and Tomonori Miura)

An on-site hydrogen production system is desired by semiconductor industries and by manufacturers of fuel cell power generators to reduce the hydrogen cost. Ammonia is a promising raw material for hydrogen production because it may solve several problems related to hydrogen transportation and storage. Hydrogen can be effectively produced from ammonia via catalytic thermal decomposition; however, the resulting residual ammonia negatively influences the fuel cells. Therefore, a high-purity hydrogen production system comprising a catalytic decomposition reactor and a plasma membrane reactor has been developed herein. Most of the ammonia is converted to hydrogen by the catalytic reactor. The product gas containing unreacted ammonia is introduced into the plasma membrane reactor, and decomposition of unreacted ammonia and separation of hydrogen are performed in the PMR, thus obtaining hydrogen at a purity of 99.999% at the output of the plasma membrane reactor. The optimal operating conditions to maximize the hydrogen production flow rate were investigated. The residual ammonia concentration, gas differential pressure and applied voltage of the plasma influenced the flow rate. The rate-controlling step in the pure hydrogen production was the adsorption of H radicals on the surface of the Pd-40%Cu membrane. A pure hydrogen flow rate of about 120 L/h was achieved with the current operating conditions. The maximum energy efficiency of the developed hydrogen production system was 28.3%.

6.3 Ammonia Decomposition Using a Plasma Reactor with a Flow Channel (Shinji Kambara, Ryoma Sakai, Haruki Kanayama, Yukio Hayakawa and Tomonori Miura)

A plasma membrane reactor with a flow channel was considered to obtain high energy efficiency in hydrogen production from ammonia. A 1-mm-wide and 1-mm-deep flow channel was fabricated on the surface of a 5-cm square quartz plate. 0.5% ammonia gas was supplied to the flow channel plasma reactor at a 0.4 L/min flow rate in object to test the configuration. The ammonia decomposition rate reached 45.4%, which represents a higher conversion efficiency than that measured in a cylindrical plasma membrane reactor with the same gas residence time. The effects of the applied voltage, gas flow rates, and ammonia concentration on the ammonia decomposition rate were investigated. The results showed that an increase in the applied voltage leads to a higher ammonia decomposition rate because the high plasma density causes greater dissociation of molecular ammonia by electron impacts. Further, increases in the ammonia gas flow rate or the ammonia concentration reduces the ammonia decomposition rate.