Hydrogen Production from Ammonia by Vacuum Ultra Violet

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A hydrogen economy has been one of the main strategies to reduce green-house gases. Fuel-cell operated vehicles (FCVs) and stationary fuel cells as power sources are expected to drastically reduce the emission of carbon dioxide gas. However, the energy loss for hydrogen transportation and storage is an obstacle on the road to a hydrogen economy. The use of ammonia as hydrogen carrier has several advantages such as low cost, ease of storage, and carbon-free at the end users. Therefore, low cost and high efficiency hydrogen production from ammonia is desired.

The absorption spectrum of ammonia consists of a long progression arising between 170 nm and 220 nm. Consequently, vacuum ultra violet (VUV) generated from an Xe excimer lamp may be available to decompose molecular ammonia into hydrogen and nitrogen.

An aluminum cylindrical chamber coaxial in configuration to the excimer lamp was used as a photochemical reactor to produce hydrogen without catalyst at room temperature. An NH_3/N_2 gas mixture was fed into the gap between the excimer lamp and the inside wall of the cylindrical chamber. The effects of ammonia concentrations and residence time on hydrogen production were investigated. The gap volume was 377 cm^3; the gas residence time in the chamber was 11.3–113 s at the NH_3/N_2 gas flow rate of 0.2–2.0 $L \cdot min^{-1}$. The radiation power of the VUV ray of 172 nm generating was 26 $mW \cdot cm^{-2}$ on the quartz glass surface of the excimer lamp. Concentrations ranged from 0.25% to 30%.

Hydrogen conversion was increased with an increase of the gas residence time and a decrease of ammonia concentration. An approximate 75% hydrogen conversion was attained at the NH_3/N_2 gas flow rate of 0.5 $L \cdot min^{-1}$ with 0.5% NH_3. Hydrogen conversion was significantly varied in the ratio of the number of photon from the VUV to the number of NH_3 molecules.

Index Terms — Vacuum ultra violet, ammonia, hydrogen, Photochemical