Formation of ultra-thin defect-free Pd-based composite membrane for membrane reactor in pre-combustion CO_2 capture process

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Abstract

Hydrogen membrane reactors attract great attention for pre-combustion CO_2 capture from fossil fuel. The performance of hydrogen membranes, especially Pd-based membranes, is essential technology for effective membrane reactors. Lots of studies focus on the hydrogen permeation flux, perm-selectivity and durability.

This study focuses on ultra-thin and high-selective Pd-based composite membrane. In order to fabricate an ultra-thin defect-free Pd-based composite membrane, sputtering and polishing method was introduced. Some pin-holes were remained after sputtering palladium followed by heat-treatment at 723 K for 2 hours. The pin-holes drastically decrease hydrogen perm-selectivity of the Pd-based composite membrane. In order to remove the pin-holes, we introduced polishing method after palladium sputtering. SEM analysis and helium leak tests showed that the polishing method was very effective to remove the pin-holes. After polishing treatment, helium leaks drastically decreased. Hydrogen permeation and helium leak tests showed that our membrane has very high perm-selectivity (~54,000) with hydrogen permeation flux of $1.8X10^{-1}$ mol m^{-2} s^{-1} at a pressure difference of 100 kPa and 673 K.

The advantage of our membrane fabrication procedures lies in its simplicity and reproducibility. We hope that our membrane can be applied to the membrane reactors for efficient conversion of fossil fuel into H_2 for power production with capture of the remaining CO_2.