PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Hydrogen and Clean Fuels from Coal

10/2007

COMPOSITE PD AND PD ALLOY POROUS STAINLESS STEEL MEMBRANES FOR HYDROGEN PRODUCTION AND PROCESS INTENSIFICATION

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Description

Hydrogen is viewed as the fuel source for the 21st century. Given the inherent advantages of coal in the United States, such as its abundance, availability, and cost-competitiveness, coal will likely play a major role in hydrogen production for the 21st century. Coal may be converted into hydrogen using gasification technology. The water-gas shift (WGS) reaction is typically used to increase hydrogen yield from coal gasification. The products from the WGS reaction (carbon dioxide and hydrogen) are separated at high (>95%) levels of purity using membranes. Combining the WGS reaction and hydrogen separation (process intensification) reduces capital costs and improves efficiency.

The objective of this project is to reduce the number of unit operations required for hydrogen production through process intensification. Worcester Polytechnic Institute (WPI), in collaboration with Adsorption Research, Inc. (ARI), will produce hydrogen using an advanced synthesis gas cleanup system and an asymmetric composite Pd-Pd/alloy membrane integrated downstream of the coal gasifier. The high-pressure carbon dioxide from the membrane shifter would be appropriate for recycling, sequestration, and/or conversion to industrially useful products.

Primary Project Goals

- Develop an advanced gas-cleaning process to reduce the sulfur compounds to <2 ppm
- Synthesize composite Pd and Pd/alloy porous stainless steel membranes by electroless plating using WPI's patented technology. (This will be done in conjunction with WPI's current DOE contract to develop sulfur-tolerant Pd/Cu alloy membranes for hydrogen separation with high-pressure carbon dioxide sequestration)

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- Perform tests using the synthesized membranes for the WGS membrane reactor, develop process intensification and control strategies for the process, and demonstrate the effectiveness and stability of the WGS membrane reactor for producing high purity hydrogen
- Perform economic analysis for the proposed process intensification strategy

Accomplishments

None at present – New project initiated in FY-2007

Benefits

The reduction of the number of process steps in hydrogen production is a key consideration in improving process cost economics. By integrating the WGS reaction with hydrogen separation, the project will develop an integrated, cost-effective hydrogen production and separation process using a unique hydrogen separation membrane for WGS reactors under process intensification conditions. Compared with unsupported metal membranes, the development of an asymmetric composite membrane with a porous support and thin Pd or Pd-alloy dense layers would provide both higher trans-membrane flux and lower Pd loading.

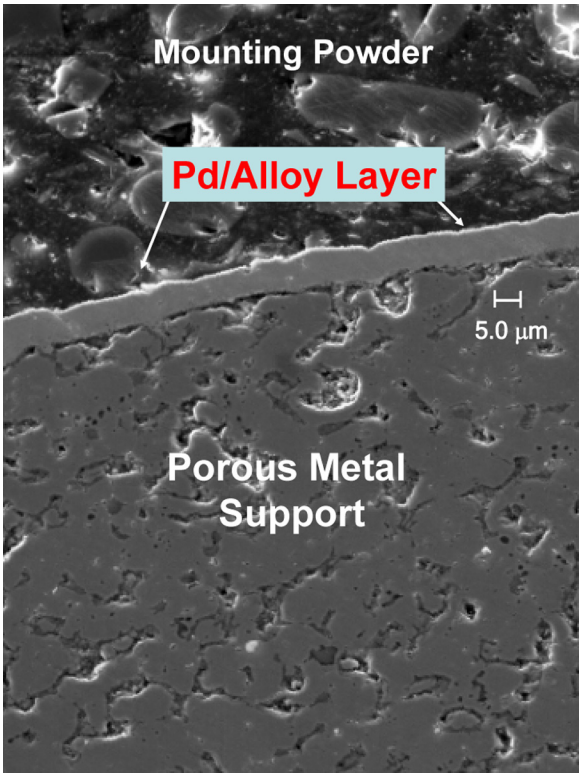

Illustration of WPI's Pd/Alloy Layer