TITLE: **FABRICATION OF Pd/Pd-ALLOY FILMS BY SURFACTANT INDUCED ELECTROLESS PLATING FOR HYDROGEN SEPARATION FROM ADVANCED COAL GASIFICATION PROCESSES**

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GRANT NO.: DE-NT0001473

PERIOD OF PERFORMANCE: 03/10/2008 – 03/09/2011

DATE: April 29, 2008

1. ABSTRACT

Program Introduction: Rational and Objective

The goal of this project is to investigate and explore the applicability of Pulsed Laser Deposition (PLD) technique as an activation step followed by surfactant induced electroless deposition as novel route to fabricate hydrogen-selective Pd/Pd-alloy composite membrane on microporous substrate for use in production and separation of hydrogen at elevated temperature and pressure. The objectives of this exploratory research are to:

1. Develop processing technology for the deposition of continuous, thin, integral, stable films of Pd/Pd-alloy on microporous stainless steel planar substrate activated by the PLD technique followed by surfactant induced electroless plating.
2. Characterize the microstructure of the Pd-composite membrane by Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM) and X-Ray Diffraction (XRD) techniques.
3. Conduct H_2-perm-selectivity tests using pure and mixed gases at elevated temperature and pressure.
4. Critically evaluate the performance of PLD-assisted activation followed by surfactant induced electroless plating Pd-composite membrane with that of conventional electroless plating Pd-composite membrane in terms of perm-selectivity, and thermal and mechanical stability of the membrane films.

The project objectives as stated will be achieved by breaking down the work into three phases.

Phase 1: Fabrication of Pd/Pd-alloy thin-film composite membranes on microporous stainless steel substrate by the PLD assisted activation followed by surfactant induced electroless plating method.

In this phase of the study, first we need to optimize the PLD method for deposition of Pd/Pd-alloy on microporous stainless steel substrate. Our initial tests will be focused on the optimization of deposition parameters to realize the best quality palladium thin films. The important parameters that need to be optimized are substrate temperature, laser fluence, pulse repetition rate and target to substrate distance. After optimizing the PLD process parameter, we will begin depositing palladium films using surfactant induced electroless plating on to stainless steel discs with different roughness, pore size and pore density. In this step, we will test several cationic surfactants including DTAB to find the right surfactant (with favorable structure and charge). The fabricated membranes will be characterized by SEM, TEM and EDX analysis for surface morphology and structural composition. Finally, each of the membranes will be tested for H_2-perm-selectivity using pure hydrogen and mixed gases at elevated temperature and pressure.

Phase 2: Long-term performance study of Pd-composite membranes under thermal cycling: Membrane Integrity/Stability Tests.

Under optimal condition (as determined in Phase 1) using the PLD assisted activation followed by surfactant induced electroless deposition method; we will fabricate several Pd/Pd-alloy composite membranes. These membranes will be tested for H_2-perm-selectivity for a long period under thermal cycling. Microstructure of each of the membranes will be characterized and evaluated by SEM, TEM and XRD techniques at different times.

Phase 3: Evaluation of PLD assisted, surfactant induced electroless deposited Pd/Pd-alloy composite membranes with that of conventional electroless plating Pd/Pd-alloy composite membranes.

We have an on-going research program on the development H_2-selective Pd-composite membranes by conventional electroless deposition method. In this phase, the results obtained from Phase 1 and 2 will be used to compare the performance of the two types of membranes (PLD assisted activation followed by surfactant induced electroless plating and conventional electroless plating – sensitization, activation and plating) in terms of H_2-perm-selectivity, and thermal and mechanical stability of the membrane films. We also will analyze the H_2 flux and permeability data for the two membranes to establish the transport behaviors in terms of similarities and dissimilarities (if any).

Accomplishment Achieved to Date

This is a new grant and we have the funding in place effective March 2008. We are in the process of recruiting one graduate and one undergraduate student to work on this project. We expect to have the students in the laboratory by the summer or beginning Fall 2008.

2. LIST OF PUBLISHED JOURNAL ARTICLES, COMPLETED PRESENTATIONS AND STUDENT RECEIVING SUPPORTS FROM THE GRANT

None