Title: Advanced Hydrogen Transport Membranes for Vision 21 Fossil Fuel Plants

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Principal Authors:

Eltron: Carl R. Evenson

CoorsTek: Richard N. Kleiner, James E. Stephan, Frank E. Anderson

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Name and Address of Submitting Organization:

Eltron Research Inc., 4600 Nautilus Court South, Boulder, CO 80301-3241

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ABSTRACT

During this final quarter of the no cost extension several planar membranes of a cermet composition referred to as EC101 containing a high permeability metal and a ceramic phase were prepared and permeability testing was performed.

EXECUTIVE SUMMARY

Eltron Research Inc. and team members CoorsTek, Süd Chemie, Argonne National Laboratory, and NORAM are developing an environmentally benign, inexpensive, and efficient method for separating hydrogen from gas mixtures produced during industrial processes, such as coal gasification. This project was motivated by the National Energy Technology Laboratory (NETL) Vision 21 initiative, which seeks to economically eliminate environmental concerns associated with the use of fossil fuels. Currently, this project is focusing on four basic categories of dense membranes: i) mixed conducting ceramic/ceramic composites, ii) mixed conducting ceramic/metal (cermet) composites, iii) cermets with hydrogen permeable metals, and iv) layered composites containing hydrogen permeable alloys. Ultimately, these materials must enable hydrogen separation at practical rates under ambient and high-pressure conditions, without deactivation in the presence of feedstream components such as carbon dioxide, water, and sulfur.

This report contains results for preparing and testing a cermet membrane referred to as EC101.

INTRODUCTION

The objective of this project is to develop an environmentally benign, inexpensive, and efficient method for separating hydrogen from gas mixtures produced during industrial processes, such as coal gasification. Currently, this project is focusing on four basic categories of dense membranes: i) mixed conducting ceramic/ceramic composites, ii) mixed conducting ceramic/metal (cermet) composites, iii) cermets with hydrogen permeable metals, and iv) layered composites with hydrogen permeable alloys. The primary technical challenge in achieving the goals of this project will be to optimize membrane composition to enable practical hydrogen separation rates and chemical stability. Other key aspects of this developing technology include catalysis, ceramic processing methods, and separation unit design operating under high pressure. To achieve these technical goals, Eltron Research Inc. has organized a consortium consisting of CoorsTek, Süd Chemie, Inc. (SCI), Argonne National Laboratory (ANL), and NORAM.

A no-cost extension was obtained to finalize cermet development at CoorsTek. Eltron Research, Inc. monitored cermet development progress and characterized appropriate materials. All other milestones and tasks were completed prior to the extension. During this final quarter of the no cost extension several planar membranes of a cermet composition referred to as EC101 containing a high permeability metal and a ceramic phase were prepared and permeability testing was performed.

EXPERIMENTAL

The Experimental Section of the first quarterly report (January 1, 2001) contained detailed descriptions of equipment and procedures to be used over the duration of this program. The specific aspects presented were: (a) preparation of ceramic powders, (b) preparation of composite materials, (c) fabrication of tube and disk membranes, (d) construction and operation of ambient-pressure hydrogen separation units, (e) construction and operation of high-pressure hydrogen separation units, (f) hydrogen transport and ambipolar conductivity measurements and calculations, and (g) fabrication of thin film ceramics. For brevity, these general issues will not be repeated. However, modification of equipment or methods, as well as any other experimentally relevant issues, will be reported in the Results and Discussion section under their corresponding Tasks as outlined in the original proposal.

RESULTS AND DISCUSSION

Tasks 1 & 2 Preparation, Characterization, and Evaluation of Hydrogen Transport Membranes

Contributors: Eltron, CoorsTek

Multi-Phase Ceramics and Cermets

CoorsTek finalized the processing conditions necessary to sinter a new cermet referred to as EC101 containing a high permeability metal and a ceramic phase. Final temperatures, ramp rates, and atmospheres resulted in a high density cermet with distinct cermet and metallic phases. Planar EC101 membranes were sealed for high temperature testing. Hydrogen permeability was determined at 350°C and under five different hydrogen concentrations in the feed stream. Testing results showed the EC101 cermet had a higher permeability than other cermets tested in the reported literature. The continued testing of EC101 and development of other cermet compositions will be transitioned to Eltron's FutureGen project.

Task 3 High Pressure Hydrogen Separation

No actions were performed on this task during this quarter.

Task 4 Thin-Film Hydrogen Separation Membranes

No actions were performed on this task during this quarter.

Task 5 Construction and Evaluation of Prototype Hydrogen Separation Unit

No actions were performed on this task during this quarter.

Task 6 Membrane-Promoted Conversion of Alkanes to Olefins

No actions were performed on this task during this quarter.

Task 7 Catalyst Membrane Compositions for Scale Up

No actions were performed on this task during this quarter.

Task 8 Manufacturing Processes for Demonstration-Scale Hydrogen Separation Membranes

No actions were performed on this task during this quarter.

Task 9 Fabrication and Evaluation of Demonstration-Scale Hydrogen Separation Unit

No actions were performed on this task during this quarter.

SUMMARY AND CONCLUSIONS

Conclusions based on the work performed during this quarter are summarized as follows:

1. Hydrogen permeability of cermet EC101 was determined.

OBJECTIVES FOR NEXT REPORTING PERIOD

The project titled “Advanced Hydrogen Transport Membranes for Vision 21 Fossil Fuel Plants” is now complete. A final report will be issued containing all results obtained.

OPEN ITEMS OR COOPERATIVE AGREEMENT CHANGES

None

TIME LINES

The time lines separated into each task are presented below, with markers indicating overall progress for each subtask.