ANNUAL PROJECT REPORT
AS OF DECEMBER 2004

1. **PROJECT SPONSOR**

Department of Chemical&Materials Engineering

The University of Cincinnati

678 ERC

Cincinnati, OH 45221-0012

2. **PROJECT MANAGER**

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3. **OCDO GRANT NO**. OCRC3-00-4, C4.14

4. **PROJECT UPDATE __OR_X**

FINAL REPORT

5. **PROJECT TITLE**: Novel Amine-Modified Silica Membranes for Separation of Carbon Dioxide under Ambient Conditions

6. **PROJECT TERM: FROM**: 9/1/03 **TO**: 8/31/04

7. **BUDGET:**

NAME	**COST SHARE**
OCDO	$80,000
Univ. Cincinnati	$30,620
TOTAL PROJECT COST	$110,620

I. ABSTRACT

8. OVERVIEW OF PROJECT & OBJECTIVES:

Reducing atmospheric CO_2 emissions from dilute sources, such as flue gas from coal-fired power plants, is becoming increasingly important for addressing climate change concerns. Therefore, capturing CO_2 from flue gas is an important step for many mitigation technologies. Membrane separation methods are particularly promising for CO_2 separation from flue gas due to high CO_2 selectivities and fluxes achievable and favorable process economics. The focus of the proposed research is to develop novel amine-modified mesoporous silica membranes for CO_2 separation from flue gas. The overall objective of the three-year research program is to establish amine-modified silica membranes as a new viable technology for capturing CO_2 from flue gas.

9. WORK DONE & CONCLUSIONS:

In preceding year the project focused on the synthesis of CO_2-selective mesoporous silica membranes containing surface amino groups and their use in CO_2 separation from N_2. We successfully prepared defect-free mesoporous silica membranes on both symmetric and asymmetric alumina supports by surfactant extraction and attached small amino groups, e.g. aminopropyl, to their pore surface. We also attached small polymeric amines, e.g. polyethyleneimine (PEI), to the pore surface of mesoporous silica membranes and discovered that these novel membranes were highly efficient in separating N_2 from CO_2 in the presence of poisture, α (N_2/CO_2)~ 15-60 and N_2 permeance ~10^{-7} mol/$m^2 \cdot s \cdot Pa$. These membranes are highly promising for separating N_2, the majority flue gas component, from CO_2 and other acid gas impurities, such as SO_x, which may eliminate the need for a wet scrubber with associated capital and process costs.

II. HIGHLIGHTS/ACCOMPLISHMENTS

Discovery of novel PEI-modified MCM-48 membranes that are highly efficient in separating N_2 from CO_2, α (N_2/CO_2)~ 60 and N_2 permeance ~10^{-7} mol/$m^2 \cdot s \cdot Pa$.

III. ARTICLES/PRESENTATIONS

1. V.V. Guliants, J. Ida, Y.S. Lin, "Ordered mesoporous silica membranes for CO_2 separation. Part I: preparation and structural characterization", *J. Membr. Sci.* (2005), in preparation.
2. S. Kim, V.V. Guliants, J. Ida, Y.S. Lin, "Ordered mesoporous silica membranes for CO_2 separation. Part II: permeation of CO_2 and other small molecules", *J. Membr. Sci.* (2005), in preparation.
3. S. Kim, J. Ida, V.V. Guliants and Y.S. Lin, "Tailoring Pore Properties of MCM-48 Silica for Selective Adsorption of CO_2", *J. Phys. Chem. B* (2005), in print.
4. S. Kim, V.V. Guliants, J. Ida, Y.S. Lin, "Ordered mesoporous silica membranes for CO_2 separation from flue gas", *Int. J. Environ. Pollution* (2004), *4(1/2)*, 21-31
5. V.V. Guliants, M. Carreon, and Y.S. Lin, "Ordered mesoporous and microporous inorganic films and membranes", *J. Membr. Sci.* (2004), *235(1-2),* 53-72.
6. S. Kim, V.V. Guliants, J. Ida, Y.S. Lin, "Ordered mesoporous silica membranes for CO_2 separation from flue gas", *Preprints of Symposia - American Chemical Society*, *Division of Fuel Chemistry* (2003), 48(1), 392-393.