

# Standardization of Methods for the Characterization of Inorganic Membranes

Poster presented at the  
IUPAC Congress/General Assembly  
*July 2001*

# Project Objectives

- To indicate the practical capabilities of physical and physico-chemical properties for, specifically, the characterization of inorganic membranes
- To determine an efficient methodology for the determination of inorganic membrane properties of practical importance
- To draw attention to unresolved or unaddressed issues that deserve experimental attention

# Background

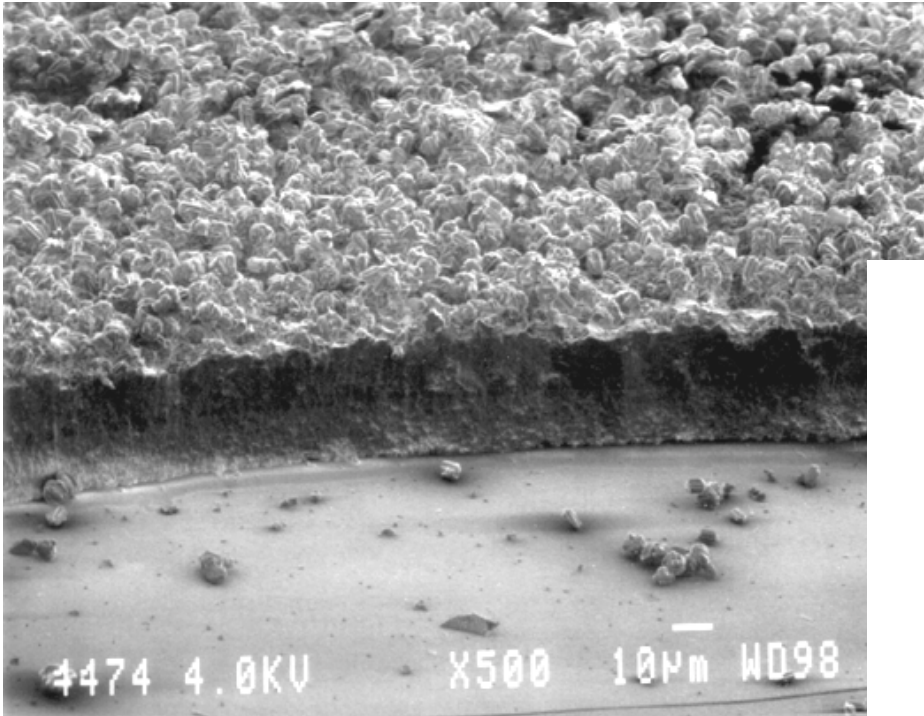
In the past decade, there has been a rapid growth in the number of publications dealing with synthesis and characterization of inorganic membranes. Furthermore, the increased industrial interest has been demonstrated by the recent formation of two multi-consortiums to develop inorganic membranes for partial oxidation of methane to synthesis gas. Such a large increase in the interest in the development of a new generation of inorganic membranes is, at least, due in part to their excellent chemical, thermal, and mechanical stability.

Therefore, the **development of standard characterization procedures** for the evaluation and comparison of the important characteristics of inorganic membranes is essential to facilitate information exchange among researchers and industrial practitioners and to enhance the membrane development.

# Procedure

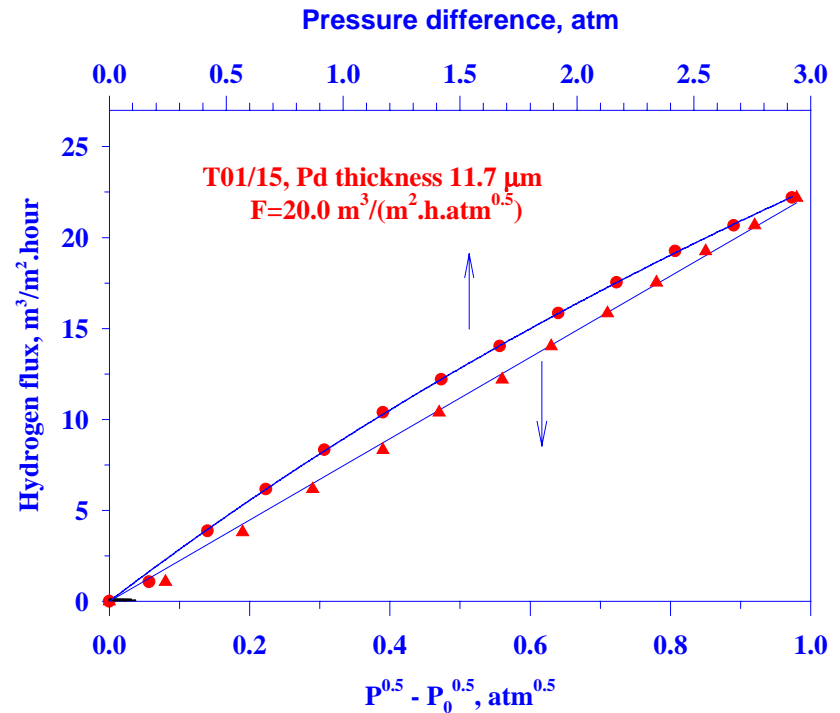
- Organization of two workshops to address the issues and techniques
- Formation of a Task Group consisting of researchers from both academia and industry
- Implementation of surveys to obtain additional information on characterization techniques and suggestions for new techniques
- Selection of a preliminary list of suggested standardized characterization methods
- Distribution of the preliminary list to researchers for comments and suggestions
- Formulation of the final recommendations to IUPAC for review and approval

# *making sense of inorganic membrane characterization*



SEM micrograph of the cross section of a silicalite membrane supported on  $\gamma$ -alumina disk

Hydrogen flux for a Pd membrane as a function of the difference of the square root of pressure (Sievert's law) at 350°C



# Project Contents

- **Characterization of physical properties of inorganic membranes (e.g., porosity, pore size distribution, membrane thickness) With an emphasis on well-established general techniques (e.g., mercury porosimetry, adsorption and desorption Isotherms, calorimetric measurements, SEM, TEM, NMR, and AFM)**
- **Transport properties characterization by dynamic techniques (e.g., bubble point, liquid/gas permeance measurements, and permoporometry)**

# Contents *(continued)*

- **Development of standards for protocols, data analysis, and reporting formats**
- **Development of standards for experimental conditions for characterizations (e.g., temperature, pressure, standard gases, and mixture gas measurements)**

# First Workshop

- *Chairmen:*  
Professors Louis Cot and Yi Hua Ma
- *Place:*  
Montpellier, France  
In conjunction with the  
3rd International  
Conference on Inorganic  
Membranes
- *Date:* June 25, 2000
- *Number of  
Participants:* ~ 100
- *Number of Invited  
Presentations:* 6

- Microstructure, Structure, and Defect  
Structure Characterization in Mixed  
Conductor Membrane Materials

**R. Bredsen, Norway**

- Present Status of the “CHARMME” Network:  
Harmonization of Characterization Procedure  
for Porous Membranes

**C. Guizard, France**

- An Overview of Techniques for Membrane  
Characterization

**T. Tsotsis, USA**

- Characterization of Inorganic Membranes by  
Radiation Scattering and Spectroscopic  
Techniques

**J. Ramsay, France**

- Status of Zeolite Membrane Characterization

**R. Noble, USA**

- Characterization of Pd and Pd/Alloy  
Membranes

**J. D. Way, USA**



# Current and Future Activities

- Organization of the Second Workshop
- Continuation of the formation of the Task Group with emphasis on recruiting more industrial members
- Formation of subgroups within the Task Group and assignment subareas to each subgroup
- Implementation of surveys and selection of a preliminary list
- Distribution of the preliminary list for comments and suggestions from academic and industrial researchers
- Formulation of the final recommendations to IUPAC for review and approval

## Task Group Chair:

Ed Yi Hua Ma

**TG Members:** L. Cot, J.A. Dalmon, I. Dekany, D. Fain, J. Falconer, J.H. Fendler, H. Fleming, G.R. Gavalas, W.S. Winston, E. Kikuchi, W.J. Koros, Y.S. Lin, V. Linkov, S. Nakao, R.D. Noble, J. Pellegrino, J.D.R. Ramsay, J. Santamaria, T.T. Tsotsis, J. D. Way, N. Xu

- Part of the **IUPAC Strategic Initiative on Materials**
- Proposed Duration: 2 years (started in June 2000)
- TG to be completed by addition of members from both industry and academia