



FERRET

A FLEXIBLE NATURAL GAS MEMBRANE REFORMER FOR M-CHP APPLICATIONS

FCH JU GRANT AGREEMENT NUMBER: 621181

Start date of project: 01/04/2014

Duration: 3 years

WP3 – Membrane Development and Scale-up

D3.8

Public report on the manufacturing and characterization of the membranes delivered to WP5

Application area: SP1-JTI-FCH.3: Stationary Power Generation & CHP
Topic: SP1-JTI-FCH.2013.3.3 Stationary Power and CHP Fuel Cell System Improvement Using Improved Balance of Plant Components/Sub-Systems and/or Advanced Control and Diagnostics Systems
Funding scheme: Collaborative Project
Call identifier: FCH-JU-2013-1

Due date of deliverable: 2016-05-31	Actual submission date: 2016-09-02	Reference period: 2015-10-31 – 2017-03-31
Document classification code (*): FERRET-WP3-D38-DLR-TECNALIA-20160902-v01.doc		Prepared by (**): TECNALIA

Version	DATE	Changes	CHECKED	APPROVED
v0.1	2016-09-02	First Release	TECNALIA	Ekain Fernandez

Project co-funded by the FCH JU within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	
CON	Confidential, only for members of the Consortium	

(*) for generating such code please refer to the Quality Management Plan, also to be included in the header of the following pages

(**) indicate the acronym of the partner that prepared the document



D3.8
**Public report on the manufacturing and
characterization of the membranes
delivered to WP5**

Proj. Ref.: FERRET-621181
Doc. Ref.: FERRET-WP3-D37-DLR-
TECNALIA-20160902-v01.doc
Date: 2016/09/02
Page Nº: 2 of 5

Content

1. EXECUTIVE SUMMARY.....	3
1.1. Description of the deliverable content and purpose	3
1.2. Brief description of the state of the art and the innovation brought	3
1.3. Deviation from objectives	3
1.4. If relevant: corrective actions	3
1.5. If relevant: Intellectual property rights	3
2. Manufacturing of Pd-based membranes for pilot-scale membrane reactor	4
3. Sealing of Pd-based membranes for pilot-scale membrane reactor.....	5
4. References.....	5



D3.8
**Public report on the manufacturing and
characterization of the membranes
delivered to WP5**

Proj. Ref.: FERRET-621181
Doc. Ref.: FERRET-WP3-D37-DLR-
TECNALIA-20160902-v01.doc
Date: 2016/09/02
Page N°: 3 of 5

1. EXECUTIVE SUMMARY

1.1. Description of the deliverable content and purpose

This deliverable reports the manufacturing (including sealing step) and characterization of the Pd-based supported membranes delivered for the prototype membrane reactor to HyGear (WP5). After the lab-scale tests of different type of membranes, thin Pd-Ag membranes supported onto 10/7 mm asymmetric ceramic supports have been selected for the prototype membrane reactor. 34 membranes of 22-23 cm long have been prepared and they have been sealed in pairs. The sealed double membranes showed low leak rate level being suitable for the prototype membrane reactor tests.

1.2. Brief description of the state of the art and the innovation brought

N/A

1.3. Deviation from objectives

There are no deviations from objectives.

1.4. If relevant: corrective actions

N/A

1.5. If relevant: Intellectual property rights

N/A

2. Manufacturing of Pd-based membranes for pilot-scale membrane reactor

Thin Pd-Ag supported membranes have been prepared for pilot-scale membrane reactor by deposition of thin Pd-Ag layers using electroless plating technique onto asymmetric alumina tubes with a 110 nm pore size zirconia top layer (10/7 mm o.d./i.d.) provided by Rauschert Kloster Veilsdorf. 34 membranes of 22-23 cm long before the sealing have been prepared for pilot-scale MR as requested by HyGear. In Figure 1 a batch of 10 membranes is presented. The thickness of the Pd-Ag membranes has also been characterized, being around 3 microns thick as shown in Figure 2.



Figure 1. Pd-Ag supported membranes for prototype before sealing.

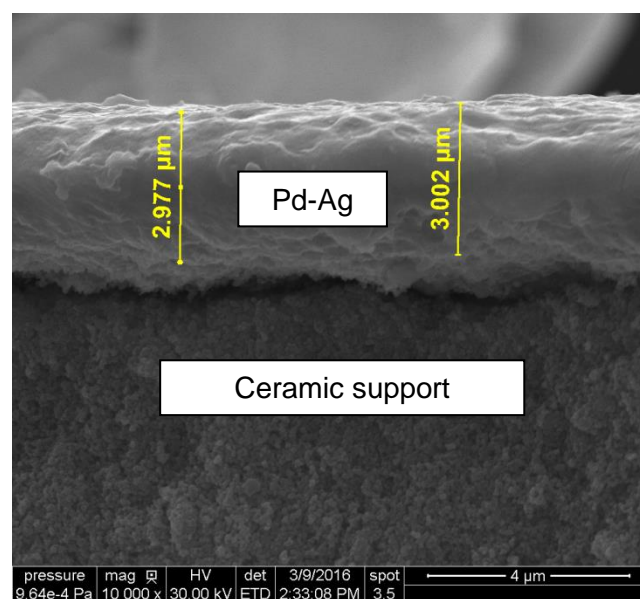


Figure 2. Cross section SEM image of a Pd-Ag supported membrane delivered for prototype reactor

Before the delivery, the nitrogen permeance at room temperature of each membrane was measured and the membranes showed a N_2 permeance of $4.7 \pm 3.1 \times 10^{-10} \text{ mol m}^{-2} \text{ s}^{-1} \text{ Pa}^{-1}$, being an acceptable leak rate.

3. Sealing of Pd-based membranes for pilot-scale membrane reactor

The membranes have been sealed in pairs by TU/e and HyGear following the procedure reported before by TU/e and TecNALIA [1]. The attachment of the seals has slightly reduced the length of the membranes; Figure 3 shows the sealed double membranes at HyGear before their integration in the prototype reactor. Besides, the leak rates of the sealed double membranes were acceptable for the integration of the membranes in the prototype membrane reactor (N_2 permeance at room temperature of $4.4 \pm 4.5 \times 10^{-10} \text{ mol m}^{-2} \text{ s}^{-1} \text{ Pa}^{-1}$).



Figure 3. Sealed double membranes before being integrated in the prototype membrane reactor.

4. References

[1] E. Fernandez, A. Helmi, K. Coenen, J. Melendez, J.L. Viviente, D.A. Pacheco Tanaka, M. van Sint Annaland, F. Gallucci, Development of thin Pd–Ag supported membranes for fluidized bed membrane reactors including WGS related gases. *Int. J. Hydrogen Energy* 40 (2015) 3506–3519.