



# GAIA

## NEXT GENERATION AUTOMOTIVE MEMBRANE ELECTRODE ASSEMBLIES

**Grant agreement no.: 826097**

**Start date: 01.01.2019 – Duration: 36 months**

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### DELIVERABLE REPORT

#### D 3.1: BASELINE IONOMER AND REINFORCEMENT COMPONENTS DELIVERED

Due Date	30th April 2019
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Workpackage	WP3
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Lead Beneficiary	CNRS
Date released by WP leader	26th June 2019
Date released by Coordinator	5th July 2019

#### DISSEMINATION LEVEL

<b>PU</b>	Public	<b>X</b>
<b>PP</b>	Restricted to other programme participants (including the Commission Services)	
<b>RE</b>	Restricted to a group specified by the consortium (including the Commission Services)	
<b>CO</b>	Confidential, only for members of the consortium (including the Commission Services)	<b>X</b>

#### NATURE OF THE DELIVERABLE

<b>R</b>	Report	<b>X</b>
<b>P</b>	Prototype	
<b>D</b>	Demonstrator	
<b>O</b>	Other	

<b>SUMMARY</b>	
<b>Keywords</b>	<i>D3.1, Ionomer, PFSA, Reinforcement, PBI, Membrane</i>
<b>Abstract</b>	This report identifies the reference membrane and catalyst layer ionomer, the baseline components comprising the baseline membrane, and the baseline catalyst layer ionomer. While “reference” refers here to materials that are already available and in use in industry, “baseline” refers to materials that are at a certain stage of development and that represent a starting point for the development work in GAIA.
<b>Public abstract for confidential deliverables</b>	This report identifies the reference membrane and catalyst layer ionomer, the baseline components comprising the baseline membrane, and the baseline catalyst layer ionomer. While “reference” refers here to materials that are already available and in use in industry, “baseline” refers to materials that are at a certain stage of development and that represent a starting point for the development work in GAIA.

<b>REVISIONS</b>			
<b>Version</b>	<b>Date</b>	<b>Changed by</b>	<b>Comments</b>
<b>1.0</b>	24.06.2019	Deborah Jones	First version released

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## **D3.1: BASELINE IONOMER AND REINFORCEMENT COMPONENTS DELIVERED**

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## 1. INTRODUCTION

Two sets of materials or components were identified, termed respectively “reference” and “baseline”, the distinction being that reference materials are used in commercial products and thereby form an industry reference, while baseline materials form the starting point for the research and development work in WP3 of GAIA.

## 2. SCOPE

### a. REFERENCE MEMBRANE

The reference membrane is the V10i membrane produced at JMFC. This membrane comprises the 3M EW 800 ionomer, the 3M chemical stabilisation package, and an ePTFE reinforcement termed ePTFE2. The ePTFE2 reinforcement was developed with outside suppliers during VOLUMETRIQ, and it improves upon the properties of standard ePTFE reinforcement materials, in particular, its swelling in the two in-plane directions is close to isotropic. The V10i membrane has thickness of 15 µm. It comprises ceria-based additives from 3M.

### b. REFERENCE CATALYST LAYER IONOMER

The reference catalyst layer ionomer is Nafion EW 1100, selected since it is the ionomer used in the CCMs comprising the V10i membrane prepared at JMFC in WP5.

### c. BASELINE MEMBRANE IONOMER

The baseline ionomer used in initial membrane development is the EW 800 PFSA produced by 3M (Figure 1). This ionomer has a nominal ion exchange capacity of 1,25 meq/g.

Figure 1 shows the polymer repeat units of the 3M and Nafion ionomers.

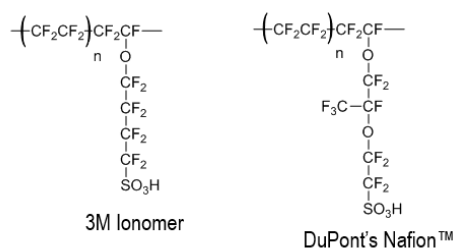


Figure 1: (left) 3M ionomers used in reference and baseline membranes (EW 800 meq/g) and baseline catalyst layer ionomer (EW 725 meq/g) and (right) Nafion ionomer (EW 1100 meq/g) used as reference catalyst layer ionomer.

### d. BASELINE CATALYST LAYER IONOMER

The baseline catalyst layer ionomer is the EW 725 PFSA produced by 3M (Figure 1), with a nominal ion exchange capacity of 1,38 meq/g.

### e. BASELINE REINFORCEMENT

Polybenzimidazole (PBI) has the highest tensile, shear, and compressive strength of any thermoplastic, and its tensile properties increase with temperature up to 150 °C. CNRS has developed nanofibre webs of different types of PBI deposited by electrospinning, and developed their use as membrane reinforcements, in technology patented with JMFC<sup>1</sup>. The viability of scale-up route was demonstrated in VOLUMETRIQ, where scale-up with Elmarco's needle-less technology produced several tens of linear metres of reinforcement material, Figure 2. The final electrospun web PBI type from VOLUMETRIQ (PBIX) having been successfully implemented in membrane production at JMFC, is transferred to GAIA where it forms the baseline reinforcement.



Figure 2: (left) 3M Electrospun web roll of polybenzimidazole produced at Elmarco.

### f. BASELINE MEMBRANE

The baseline membrane comprises the baseline ionomer and baseline reinforcement components, respectively PFSA EW 800 ionomer and the PBIX electrospun reinforcement, and it also includes a ceria-based chemical stabilisation additive from 3M. The baseline membrane thickness is 15 µm.

## 3. MATERIALS DELIVERIES

Table 1: Membrane baseline component deliveries.

Supplier	Component	Delivery to Partner
Dyneon	3M ionomers EW 725 and 800	CNRS, JMFC
Elmarco	PBIX reinforcement (batch produced during VOLUMETRIQ)	JMFC
CNRS	PBIX reinforcement	CNRS

## 4. CONCLUSIONS AND FUTURE WORK

Identification of the reference membrane provides the means for comparison of GAIA membranes with a product in commercial use (reference membrane V10i). Identification of the baseline components kicks off the development activity in WP3 and enables preparation of the first GAIA membranes associating the 3M 800 ionomer and the PBIX

type electrospun reinforcement. Future work is the preparation at lab-scale, as well as using the development and/or production coating lines of the first GAIA membrane for mechanical and other ex situ characterisation, performance and durability testing.

## 5. REFERENCES

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<sup>i</sup> WO2016020668A1 to JMFC, CNRS-Univ. Montpellier