

# DuPont Fuel Cells

## DuPont™ Nafion® PFSA Membranes

### XL Membrane

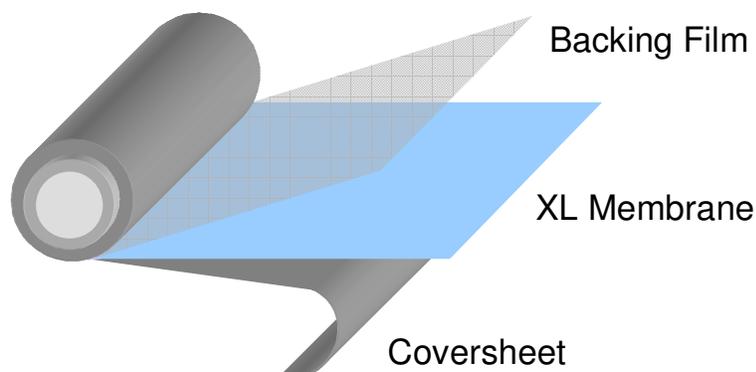
#### Description

Nafion® PFSA membranes are widely used for Proton Exchange Membrane (PEM) fuel cells and water electrolyzers. The membrane performs as a separator and solid electrolyte in a variety of electrochemical cells that require the membrane to selectively transport cations across the cell junction.

DuPont™ Nafion® XL membrane is an extended-lifetime reinforced membrane based on chemically stabilized perfluorosulfonic acid/PTFE copolymer in the acid ( $H^+$ ) form. The reinforcement improves the membrane's handling and physical properties. When the reinforcement is combined with the chemically stabilized polymer, the membrane exhibits both substantially lower fluoride ion release and longer operating durability under fuel cell conditions.

The membrane is positioned between a backing film and a coversheet. This composite is wound on a plastic core, with the backing film on the core-side, as shown in Figure 1. A 6 inch ID plastic roll core is standard.

**Figure 1: Roll Unwind Orientation (Coversheet Facing Out)**



The backing film facilitates transporting the membrane into automated MEA fabrication processes, while the coversheet protects the membrane from exposure to the environment during intermediate handling and processing. In addition, the coversheet (in combination with the backing film) eliminates rapid changes in the membrane's moisture content, and stabilizes the dimensions of the membrane when removed from the roll.

## Properties of Nafion<sup>®</sup> PFSA Membrane

### A. Thickness and Basis Weight Properties<sup>1</sup>

Membrane Type	Typical Thickness (micrometer)	Basis Weight (g/m <sup>2</sup> )
XL	27.5	55

### B. Physical Properties

Property <sup>2</sup>	Typical Values		Test Method
	MD	TD	
<b>Physical Properties</b>			
- measured at 50% RH, 23 °C			
Tensile Strength, max., MPa	45	40	ASTM D 882
Non-Std Modulus, MPa	613	400	ASTM D 882
Elongation to Break, %	200	185	ASTM D 882

### C. Other Properties

Property	Typical Values	Test Method
Conductivity <sup>3</sup> , mS/cm		DuPont
- In-Plane	> 72.0	
- Through-Plane	> 50.5	
Hydrogen Crossover <sup>4</sup> , (ml/min·cm <sup>2</sup> )	< 0.015	DuPont

### D. Hydrolytic Properties

Property	Typical Values	Test Method
<b>Hydrolytic Properties</b>		
Water content, % water <sup>5</sup>	5.0 ± 3.0%	ASTM D 570
Water uptake, % water <sup>6</sup>	50.0 ± 5.0%	ASTM D 570
Linear expansion, % increase		
from 50% RH, 23 °C to water soaked, 23 °C	1% (MD), 5% (TD)	DuPont
from 50% RH, 23 °C to water soaked, 100 °C	3% (MD), 11% (TD)	DuPont

<sup>1</sup> Measurements taken with membrane conditioned to 23 °C, 50% RH.

<sup>2</sup> Where specified, MD - machine direction, TD - transverse direction. Condition state of membrane given.

<sup>3</sup> Conductivity measurements at 23 °C, 100% RH.

<sup>4</sup> Hydrogen crossover measured at 65 °C, 100% RH. This is not a routine test.

<sup>5</sup> Water content of membrane conditioned to 23 °C and 50% RH (dry weight basis).

<sup>6</sup> Water uptake from dry membrane to conditioned in water at 100 °C for 1 hour (dry weight basis).

## Order and Packaging Information

The standard product dimensions for membrane rolls include:

**Width:** Standard width is 12-in (305-mm); other widths are available from 190mm to 368mm in 3.175mm increments on special order

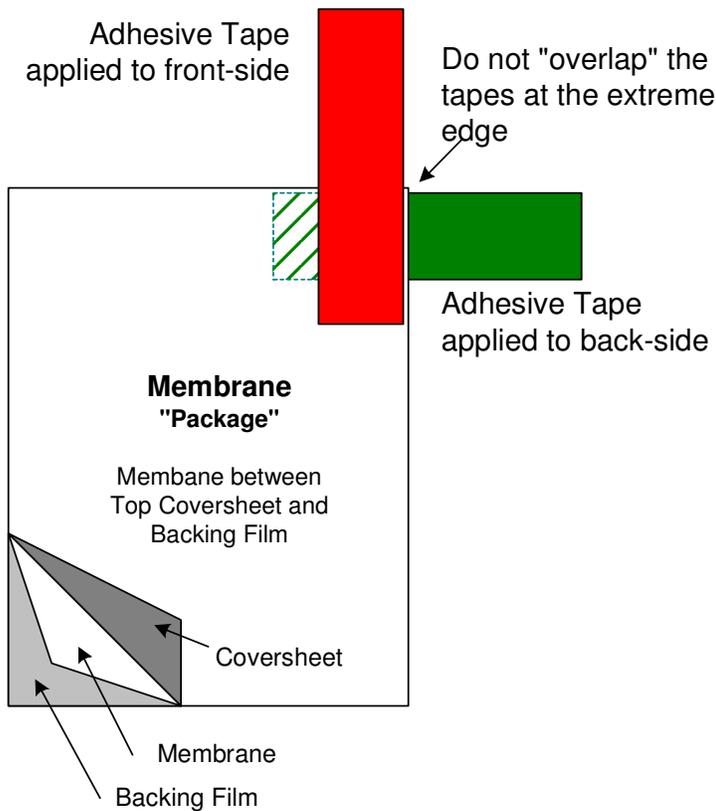
**Length:** 100-meter standard roll lengths, and intermediate lengths of 20-meter and 50-meter are available on special order.

There is a 100-m<sup>2</sup> minimum order requirement for **non-standard** roll widths; and a per roll packaging surcharge for standard widths in non-standard lengths less than 100-meters. Please contact DuPont Customer Service for details and availability.

Rolls are splice-free. Multiple rolls may be shipped to meet orders for non-standard lengths.

The water content and conditioning of the membrane will affect its dimensions, and the change may not be symmetrical in the length, width, and thickness directions. Once the cover sheet and backing film are removed, the membrane will respond to the environmental conditions of the workplace. If the membrane remains on the backing film, the membrane's response to relative humidity conditions, for example, may cause the combination of membrane/backing film to curl. In addition, certain manufacturing steps performed by the customer also may affect the membrane's dimensions and flatness.

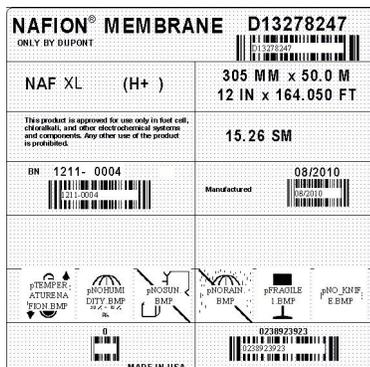
## Separating XL Membrane from the Coversheet and Backing Film:



- Attach tapes to front and back sides of the membrane "package" at one corner, as shown in the diagram. To prevent the tapes from sticking to each other, do not "overlap" the adhesive surfaces at the extreme edges.
- Pull the tapes apart to separate the coversheet from the membrane/backing film. The membrane typically adheres to the backing film during this step. The coversheet is 1-mil polyester film.
- Attach tapes to the membrane side and the backing film side at one corner, as shown in the diagram. To prevent the tapes from sticking to each other, do not "overlap" the adhesive surfaces at the extreme edges.
- Pull the tapes apart to separate the membrane from the backing film, which is a 3-mil polyester film.

## Product Labeling

A self-adhesive product label, similar to Figure 2, is located on the inside of the roll core and on the outside over-wrap of each roll. The label indicates the product roll's width and length in both Metric and English units.



**Figure 2: Finished Product Roll Label**

- **GMC (D code)** is a product setup code specific to the thickness, roll width and length, and other packaging features.
- **BN** is a 2-part code, with the first part identifying the production lot, and the second part indicating the master roll number (wide-stock roll before slitting).
- **Manufacture Date** is the wide-stock roll's slit date (mm/yyyy).
- **Tracking Code / Bar Code** generated for each product roll.

## Recommended Roll Storage Conditions

Unopened roll packages of Nafion® PFSA membrane should be stored in the original shipping box, out of direct sunlight, and in a climate-controlled environment, maintained at 10 to 30°C, and 30 to 70% relative humidity. Before opening the package, pre-condition the membrane roll to the processing area temperature for 24 hours.

Once opened and exposed to the environment, the membrane will equilibrate to the ambient relative humidity, and change in dimensions accordingly. Membrane order dimensions are specified and measured at 23°C and 50% Relative Humidity.

## Handling Practices

Ventilation should be provided for safe handling and processing of Nafion® PFSA membrane. The amount of local exhaust necessary for processing Nafion® PFSA membrane at elevated temperatures will depend on the combined factors of membrane quantity, temperature, and exposure time.

## Scrap Disposal

Preferred disposal options are (1) recycling and (2) landfill. Incinerate only if incinerator is capable of scrubbing out hydrogen fluoride and other acidic combustion products. Treatment, storage, transportation, and disposal must be in accordance with applicable federal, state/provincial and local regulations.

## Static Discharges

The composite structure and individual layers can pick up a strong charge of static electricity because of the good dielectric properties of the Membrane, Backing Film, and Coversheet. Unless this charge is dissipated as it forms, by using ionizing radiation devices or special conducting metal tinsel, it can build to thousands of volts and discharge to people or metal equipment. In dust- or solvent-laden air, a flash fire or an explosion could follow. Extreme caution is needed to prevent static accumulation when using flammable solvents while coating membrane surfaces. Solvent-coating equipment should incorporate the means for detecting and extinguishing fire.

## Safe Handling and Use of Nafion® PFSA Membranes

The following information should be reviewed before handling and processing Nafion® PFSA Membranes:

- "Safe Handling and Use of Perfluorosulfonic Acid Products" bulletin (DFC301.0708).
- "Guide to Safe Handling of Fluoropolymer Resins", Fourth Edition, November 2005, Published by the Fluoropolymers Division of the Society of the Plastics Industry, Inc.

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The data listed here fall within the normal range of product properties, but they should not be used to establish specification limits nor used alone as the basis of design. This information is based on technical data that DuPont believes to be reliable. It is intended for use by persons having technical skill and at their own discretion and risk. This information is given with the understanding that those using it will satisfy themselves that their particular conditions of use present no health or safety hazards. Because conditions of product use are outside our control, DuPont makes no warranties, express or implied, and assumes no obligation or liability in connection with any use of this information or for results obtained in reliance thereon. The disclosure of the information is not a license to operate under or a recommendation to infringe any patent of DuPont or others.

**Caution:** Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see "DuPont Medical Caution Statement", H-50102.