

# DuPont Fuel Cells

## DuPont™ Nafion® PFSA Membranes

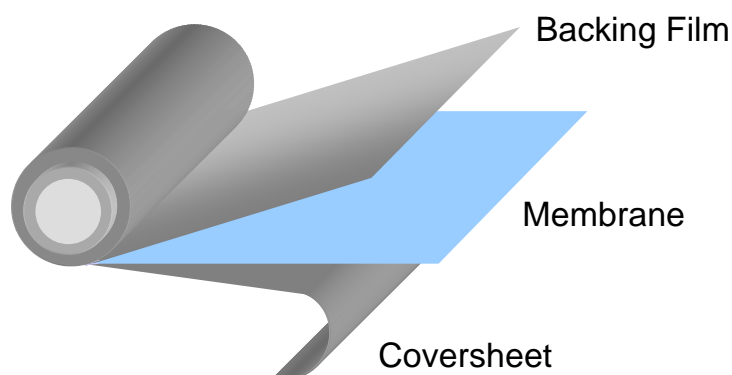
### NR211 and NR212

#### Description

DuPont™ Nafion® PFSA NR211 and NR212 membranes are based on chemically stabilized perfluorosulfonic acid/PTFE copolymer in the acid ( $H^+$ ) form, and exhibit substantially lower fluoride ion release compared to the non-stabilized polymer – a sign of improved chemical durability. 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. The polymer is chemically resistant and durable.

The membrane is positioned between a backing film and a coversheet. This composite is wound on a 6 inch ID plastic core, with the backing film facing out, as shown in Figure 1. A 6 inch ID plastic roll core is standard; however, a 3 inch ID plastic roll core is used for roll lengths that are less than 25 meters long.

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



The 3.0-mil backing film facilitates transporting the membrane into automated MEA fabrication processes, while the 0.92-mil 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 as it is removed from the roll.



*The miracles of science™*

## Order and Packaging Information

Nafion® PFSA membranes are available in two thickness values: NR211 (1-mil) and NR212 (2-mil).

Standard product dimensions for membrane rolls include:

**Width:** 305-mm and 610-mm standard roll widths, and intermediate widths from 200-mm (min.) up to 610-mm (max.) on special order. Intermediate widths available in increments of 3.175-mm.

**Length:** 100-meter standard roll length, and intermediate lengths of 10-meter and 50-meter on special order.

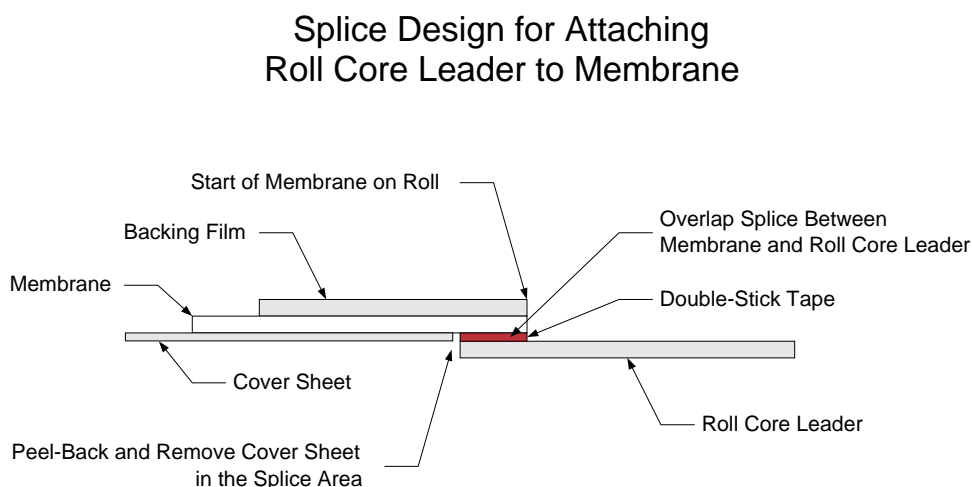
There is a 100-m<sup>2</sup> minimum order requirement for **non-standard** roll widths; and a per roll packaging surcharge for standard widths in non-standard lengths less than 100-meters. A roll core leader is available at a nominal charge per roll. Please contact Nafion® customer service for details and availability.

Rolls are splice-free when ordered in standard 100-meter lengths. Non-standard roll lengths may contain splices under the following conditions: a 5-meter minimum distance between splices and a maximum of 3 splices per roll that is less than 100-meters in length.

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 is 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.

If specified in the purchase order, a roll core leader is attached to the membrane as shown in Figure 2. The roll core leader material is the same as the backing film, and the length specified in the purchase order.

**Figure 2: Splice Design**



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

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

Membrane Type	Typical Thickness (microns)	Basis Weight (g/m <sup>2</sup> )
NR211	25.4	50
NR212	50.8	100

### B. Physical Properties

Property <sup>2</sup>	Typical Values				Test Method
	NR211		NR212		
	MD	TD	MD	TD	
<b>Physical Properties</b>					
- measured at 50% RH, 23 °C					
Tensile Strength, max., MPa	23	28	32	32	ASTM D 882
Non-Std Modulus, MPa	288	281	266	251	ASTM D 882
Elongation to Break, %	252	311	343	352	ASTM D 882

### C. Other Properties

Property	NR211	NR212	Test Method
Specific Gravity <sup>1</sup>	1.97	1.97	DuPont
Available Acid Capacity <sup>3</sup> meq/g	0.92 min.	0.92 min.	DuPont NAE305
Total Acid Capacity <sup>4</sup> meq/g	0.95 to 1.01	0.95 to 1.01	DuPont NAE305
Hydrogen Crossover <sup>5</sup> , (ml/min·cm <sup>2</sup> )	< 0.020	< 0.010	DuPont

### D. Hydrolytic Properties

Property	Typical Value	Test Method
<b>Hydrolytic Properties</b>		
Water content, % water <sup>6</sup>	5.0 ± 3.0%	ASTM D 570
Water uptake, % water <sup>7</sup>	50.0 ± 5.0%	ASTM D 570
Linear expansion, % increase <sup>8</sup>		
from 50% RH, 23 °C to water soaked, 23 °C	10	ASTM D 756
from 50% RH, 23 °C to water soaked, 100 °C	15	ASTM D 756

<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> A base titration procedure measures the equivalents of sulfonic acid in the polymer, and used the measurements to calculate the available acid capacity of the membrane (acid form).

<sup>4</sup> A base titration procedure measures the equivalents of sulfonic acid in the polymer, and used the measurements to calculate the total acid capacity or equivalent weight of the membrane (acid form).

<sup>5</sup> Hydrogen crossover measured at 22 °C, 100% RH and 50-psi delta pressure. This is not a routine test.

<sup>6</sup> Water content of membrane conditioned to 23 °C and 50% RH (dry weight basis).

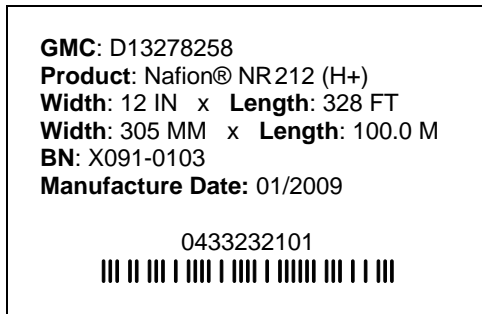
<sup>7</sup> Water uptake from dry membrane to conditioned in water at 100 °C for 1 hour (dry weight basis).

<sup>8</sup> Average of MD and TD. MD expansion is similar to TD expansion for NR membranes.

## Product Labeling

A self-adhesive product label, with information content similar to Figure 3 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 3: Finished Product Roll Label**



- **GMC** 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

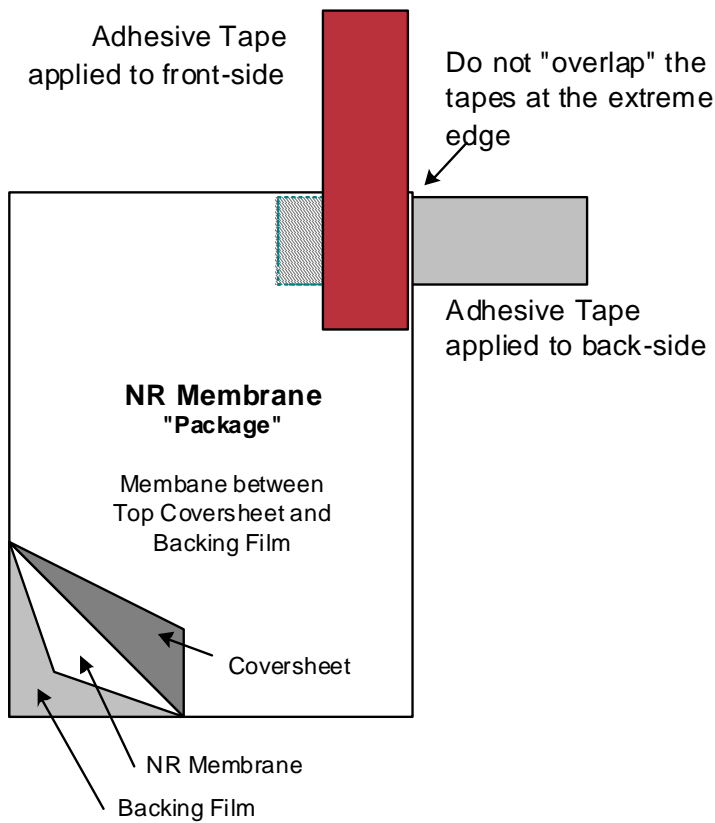
The composite structure and individual layers can pick up a strong charge of static electricity because of the good dielectric properties of the membrane, backing film, and coversheet. Unless this charge is dissipated as it forms, by using ionizing radiation devices or special conducting metal tinsel, 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:

- DuPont Material Safety Data Sheet for Nafion® PFSA Membranes NR211 and NR212
- "Safe Handling and Use of Perfluorosulfonic Acid Products" bulletin (DFC301.0209).
- "Guide to Safe Handling of Fluoropolymer Resins", Fourth Edition, November 2005, Published by the Fluoropolymers Division of the Society of the Plastics Industry, Inc.

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



- Attach tapes to front and back sides of the NR 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 0.92-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. The backing film is 3.0-mil polyester film.

## For information about product offerings from DuPont Fuel Cells, contact:

### UNITED STATES, CANADA, MEXICO and CENTRAL AMERICA

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#### Nafion® Membranes and Dispersions

##### MEA Components

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P.O. Box 80701  
Wilmington, DE 19880-0701  
Tel: (302) 774-1258 or (800) 207-0756 (USA only)

### EUROPE, MIDDLE EAST and AFRICA

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