



iPEM

Ion-Pair High-Temperature Polymer Electrolyte Membrane

Membrane Properties	
Membrane type	Proton exchange
Appearance/Color	Cloudy/orange
Thickness	60 $\mu\text{m} \pm 15 \mu\text{m}$
Ionic conductivity under ambient air with no external humidification provided	$\geq 100 \text{ mS cm}^{-1}$ at 150 °C

U.S. Provisional Patent Application 62/832,916; International Patent Application PCT/US19/27118; European Patent Application EPO/ 19784427.7; U.S. Utility Patent Application 17/046,611;

Peer-review literature reports documenting iPEM data:

Venugopalan, G.; Chang, K.; Nijoka, J.; Livingston, S.; Geise, G. M.; Arges, C. G. Stable and Highly Conductive Polycation-Polybenzimidazole Membrane Blends for Intermediate Temperature Polymer Electrolyte Membrane Fuel Cells. *ACS Applied Energy Materials* **2020**, 3 (1), 573-585.

Chaichi, A.; Venugopalan, G.; Devireddy, R.; Arges, C.; Gartia, M. R. A Solid-State and Flexible Supercapacitor That Operates across a Wide Temperature Range. *ACS Applied Energy Materials* **2020**, 3 (6), 5693-5704.

Venugopalan, G.; Bhattacharya, D.; Kole, S.; Ysidron, C.; Angelopoulou, P. P.; Sakellariou, G.; Arges, C. G. Correlating high temperature thin film ionomer electrode binder properties to hydrogen pump polarization. *Materials Advances* **2021**, 2 (13), 4228-4234.

Venugopalan, G.; Bhattacharya, D.; Andrews, E.; Briceno-Mena, L.; Romagnoli, J.; Flake, J.; Arges, C. G. Electrochemical Pumping for Challenging Hydrogen Separations. *ACS Energy Letters* **2022**, 7 (4), 1322-1329.

Note: Membrane needs to be imbibed with phosphoric acid within 24 hours before use. Next page details imbibing procedure.



Procedure for acid-imbibing iPEM

It is recommended to do the imbibing step before using the membrane in the electrochemical cell. Or, to perform the imbibing within 24 hours of use.

Materials Needed:

1. Ortho-phosphoric acid (85wt%) – 200 ml
2. Membranes cut in the desired dimensions
3. A glass container that can be closed. We usually use a glass box like the one shown in the below image. The size of the box is dependent upon the size of the membrane.



The procedure for activating the membrane is as follows:

1. Pour 200 mL ortho-phosphoric acid (85wt%) in the glass container.
2. Immerse the membrane in the phosphoric acid and close the lid of the glass container
3. Place the glass container in an oven at 120°C for 6 hours.
4. After 6 hours, remove the membrane out of the phosphoric acid carefully and blot dry the membrane. We use multiple Kim wipes to blot dry the membrane surface. Gently press the wipes against the membrane (on both sides) to blot dry the membrane. Repeat the procedure till the membrane has no visible liquid droplets on it.
5. After blot drying the membrane, it is ready for use in the electrochemical cell as a proton exchange membrane.