Polymers for Power and Optical Applications
Harry R Allcock Research Group

Fuel Cell Membranes

Anode: \( \text{H}_2 \rightarrow 2\text{H}^+ + 2e^- \)

Cathode: \( \frac{1}{2}\text{O}_2 + 2\text{H}^+ + 2e^- \rightarrow \text{H}_2\text{O} \)

Proton Exchange Membrane

Adapted from: The Polymer Electrolyte Fuel Cell
http://www.education.lanl.gov/resources/h2/gottesfeld/education.html

PEM Requirements
- Mechanical, Thermal and Chemical Stability
- Compatibility with catalysts
- Impermeable to oxygen and hydrogen
- Good water swelling properties
- High proton conductivity > 0.01 S/cm

The Chemistry of Phosphazenes

Phosphazenes are a versatile class of compounds with many potential applications. The advantage of phosphazenes lies in the tailorability of the side groups to the backbone to obtain the desired properties. To date, more than 700 phosphazenes have been synthesized.

Solid Polymer Electrolytes

SPE Requirements
- Mechanical and chemical stability
- Ability to dissolve salts
- Amorphous at room temperature
- Low glass transition temperature
- High cation conductivity > 10^-3 S/cm

Optical Materials

Phosphazene SPE Architectures

Phosphazene PEM Architectures

Light source (transmitter)

Light detector (receiver)

Electrical input signal

Lightguide

Electrical output signal

For low optical loss

For refractive index control and low optical loss

Optical Materials

Low optical loss

Refactive index control

Crosslinking

Low birefringence

Low optical loss

Refractive index control

Thermal stability

Cl + CF3CF2 or CF3OCF2CF2OCF2

Phosphazene SPE Architectures