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MOLECULAR DESIGN OF POLYMERIC MATERIALS FOR HIGH TEMPERATURE PROTON EXCHANGE MEMBRANES FOR FUEL CELLS.

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Rapid advances in the fuel cell industry have led to an increasing demand for novel proton exchange membranes (PEM) with enhanced performance. Current perfluorosulfonated ionomer (PFSI) membranes still face significant technology drawbacks that have to be overcome. These include water management at the electrodes, CO poisoning of the anode catalyst, slow cathode kinetics, and high cost of Pt electrocatalyst. It has been demonstrated that these problems can be eliminated once the operating temperature is increased to above 100°C. In practice this requires a replacement of PFSI/water combination for H^+ transport. Extensive attempts to meet these requirements have been focused on the synthesis and characterization of novel PEMs based on aromatic condensation polymers. Several novel ionomers have been prepared within this approach, containing sulfonic acid groups, or direct sulfonation of commercial aromatic polymers. Some of these polymers have demonstrated reasonable high proton conductivity at 100-120°C.

The replacement of water as conducting media is other option. This can be done using a high boiling temperature ionic liquid in combination with PFSI, or mineral acid/basic polymer complexes. PEMs based on polybenzimidazole/phosphoric acid complexes represent the most known and successful example of this approach up to the present. Celanese has launched pilot production of membrane electrode assemblies based on PBI/mineral acid solid electrolyte in 2002. The PBI/H_3PO_4 membrane reaches its maximum proton conductivity at 150-200°C. This permits significant improvement of the tolerance to CO impurities in the reformed hydrogen fuel, while water and heat management is simplified and more cost-effective. Thus, PEMs based on PBI/H_3PO_4 can be considered as a promising alternative.

The present work will consider the design molecular of chemical structures of polyimides and polybenzimidazoles for the development of high temperature proton conducting membranes. Because, these polymeric materials must contain other requirements, besides of a good proton conductivity, such as impermeability to H_2 and O_2, compatibility with catalyst, mechanical properties,etc... Which let a good performance of membrane electrode assembly (MEA).