146g Supramolecular Proton Exchange Membranes

Kevin Trembath, Alan Fuchs, and Faramarz Gordaninejad

In order to assume a leading role in the burgeoning hydrogen economy, new technologies will be required for fuel cell manufacturing and R&D capabilities. The objective of this proposal is the development of a new generation of advanced proton exchange membrane (PEM) technologies, based on advances in supramolecular chemistry and engineering, which will serve as the foundation for the development of PEM based membrane electrode assemblies (MEA's) and ultimately, fuel cells. PEM's are the most widely used membranes for fuel cell applications because of their low operating temperature and high power density. Sulfonated fluorocarbon membranes such as Nafion™, are currently the only standard membranes used in the industry, but factors such as the cost of production and poor environmental resistance have led to the investigation of novel membranes. The goal of this proposal is the development of a new generation of PEM's, which offer advantages over the Nafion PEM's and can be used in the fabrication of prototype MEA's and fuel cells. Traditional fuel sources for these cells include hydrogen / air, however more recent interest has been in direct methanol and reformate /air fuel cells. Our approach will incorporate expertise in the area of supramolecular nanocomposite design of advanced materials, membranes and devices to develop advanced PEM's and ultimately MEA's and fuel cells. This approach involves the use of membranes synthesized from polyphosphazine which are hydrogen bonded to form supramolecules. Such supramolecular interactions may be fully miscible or self organize the polymeric backbone to form two or more directional protonically conducting nanoscale channels. Furthermore, the use of inorganic proton conducting nanoparticles will provide additional strength for the PEM and increased proton conductivity. This is the first time that supramolecular structures based on ionomeric polyphosphazines will be used with nanoparticles for the synthesis of proton exchange membranes. The outcome of this work will result in a new supramolecular PEM which will have high proton conductivity and be environmentally resistant. By developing this technology a major obstacle in the emerging area of energy storage and delivery will be overcome.