

Progress Towards Robust Anion Exchange Membranes
for Fuel Cell Applications.

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The proton exchange membrane (PEM) fuel cell when using hydrogen as the fuel has a very high power density and is attractive for the automotive industry. PEM fuel cells for the automotive market are close to commercialization; the amount of Pt required is only 3x that in a typical catalytic converter and durability issues are close to being solved. However, PEM fuel cells are fuel limited to hydrogen if they are to be practical in cars requiring very high power densities. Anion exchange membrane (AEM) fuel cells could potentially use non-precious metals on both anode and cathode and should be much more fuel flexible than PEM fuel cells. We have been building AEM fuel cells based on a cationic polyphenylene polymer developed at Sandia National laboratories. I will first briefly share our experiences with this polymer and various catalysts supplied from our partners. Recently this has been modified with novel cations that allow adequate membrane stability to optimize the AEM fuel cells we are building, and recent results are quite encouraging.

The development of the AEM fuel cell is still very much a polymer problem, robust AEMs must be developed, and AEMs must be tailored specifically for the anode and cathode of the fuel cell. We have been using a ground up approach to develop new AEMs. Using di-block polymers of well-defined geometry we are exploring how fast anion transport may be achieved in AEMs. Using a wide variety of techniques it seems that a water wire is highly implied in materials that exhibit practical hydroxide conductivities. The dimensions of this are verified by small angle neutron scattering work. As a screening tool we are studying materials with fluoride counter ions. Such studies vastly increase the speed at which an AEM can be experimentally characterized and described computationally. This allows us to more rapidly screen structures for fast anion conductivities before investing in comprehensive studies of the reactive hydroxyl anion in AEMs that may not be robust enough to survive ion exchange with base.

We have recently designed a standard test for AEM stability, which is designed to both understand the mechanism of AEM degradation and to serve as a criterion for when an AEM should be selected as promising for further study. An increasing amount of our work is in film processing. As anion transport will always be slower than proton transport, it will be necessary to utilize AEMs as thin robust films. Many AEMs are intrinsically brittle; we are developing methods to form films from these materials, while understanding the polymer science.

In this talk I will give an update of efforts to make thin robust AEMs with fast anion transport and promising stability for fuel cell applications.

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