High Temperature Membrane Working Group Meeting
Thursday, October 14, 2010
Riviera Hotel
Las Vegas, Nevada

The meeting began with a welcome by Greg Kleen. This was followed by an overview of the meeting, presented by James Fenton, who also introduced the first speaker, Ahmet Kusoglu, who was presenting for Adam Weber of LBL.

Kusoglu began with a discussion of the continuum modeling of membrane properties and the general concept of modeling to investigate membranes. He discussed the motivation for the work; electrochemistry and mechanical loads co-exist but are usually modeled separately. Additionally, there is a concern that compression in a cell may alter the Transport properties. He said that the objectives of the work are to determine water uptake of compressed membranes using modeling, followed by experimental validation. Researchers are not just interest in what happens but also want to know if what will happen can be predicted.

Kusoglu continued with a discussion on the pressure that results from swelling, including what happens to the backbone of the polymer during swelling. It is necessary to bridge the macroscale information to the microscale to study this swelling pressure. The chemical potential is used to study water uptake. Compressing the membrane deforms the backbone so that more pressure is exerted. Their work has shown a good agreement between experimental data and modeling. He went on to say that continuum modeling is useful for achieving targets for both durability and performance.

He then provided a summary to their current work, including structural features, creating pathways for conditioning while keeping the membrane intact. This enables finding the optimum structure. It is necessary to look at the Young's modulus with increasing temperature. If a reinforcement phase/layer exists, it is also useful to study this.

The second speaker of the evening was Steven Hamrock from 3M, who presented a talk on durability consideration for proton exchange membranes. The membrane must, of course, act as a physical barrier to mixing gases. He explained that an operating fuel cell creates an aggressive environment for electrolyte membranes, including mechanical stresses, thermal variations and a chemically aggressive environment. He said that a membrane must also survive the fabrication process without the loss of chemical stability. He asserted that thermodynamically, no polymer membrane is stable.

Hamrock then shared data from cells tested in the field and in OCV tests. Two major issues are water and temperature management. He explained that operational issues and challenges lead to a desire for operation at hotter and drier conditions. He said that these conditions also lead to a decrease in membrane durability.

He went on to emphasize that single cell lifetime doesn't tell the whole story. Statistics are important for a stack because a single cell lifetime may not tell one how long a stack might last. He also said that failure is always related to mechanical properties of the membrane and it can be difficult to separate

chemical and mechanical components on durability. He also explained that while temperatures used on PEM fuel cells may not be high enough to cause ionomer degradation, thermal treatments are often needed to achieve good mechanical properties.

Hamrock then gave an overview of sulfonic acid chemistry at high temperatures. He went on to ask, why do we care about thermal stability? He answered that coating to form a dispersion requires heating above a set point to get good mechanical properties. He went on to discuss hydrolytic stability and said that PFSA doesn't undergo acid hydrolysis. However, with regard to oxidative stability, the formation of radicals causes attack on the membrane or can add to the aromatic rings. He then gave an overview of the degradation in which unzipping of the polymer backbone occurs. There is also attack on side-chains, which is evidenced by the identification of side-chain fragments.

Hamrock asked if this is relevant to lifetime under accelerated testing. No data exists to confirm that changing the equivalent weight makes a difference. However, oxidative stability versus EW does indicate a relationship. He also said that the Fenton's test is useful but not a way to predict how long an MEA will last in a fuel cell. It is very important to control conditions under which the Fenton's test is run, including very careful control of the pH. His talk concluded with a discussion of solubility and loss of crystallinity.

The last speaker of the evening, Kevin Cooper from Scribner Associates presented a status report on through-plane conductivity measurements. He emphasized that there is a large discrepancy in the reported conductivity data, which highlights the need for an accurate, robust method of measurement. He followed with a list of the features desired in a device for measuring conductivity and presented a schematic of the MTS 740 membrane test system developed by Scribner Associates. Data was presented to show that the method results in repeatable, reproducible data. Data was also presented to compare the through-plane data to in-plane conductivity. The two methods were shown to give good agreement at each set of conditions.

Cooper also presented a discussion as to what is area specific resistance (ASR). So far, there does not seem to be a great deal of agreement on what the term means or how it is calculated or measured.

The meeting concluded after a brief general discussion.