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The Investigation and Characterization of Next Generation Proton Exchange Membranes for Fuel Cell-based Ethanol Sensors

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Proton exchange membrane fuel cells (PEMFCs) are one of the most innovative and adaptable fuel cell technologies. One of the most important niches that PEMFCs have a proven commercial market is in sensory devices. When configured for sensory operation the current produced in a fuel cell is proportional to how much fuel is passed through the device. Another important note is that hydrogen is not the only fuel that can power a fuel cell; ethanol is also commonly used. The current produced is directly related to the concentration of ethanol in the fuel. This type of sensing is most notably found in a breath alcohol sensor (BAS) commonly used for road side detection of impaired driving.

The purpose of the BAS is to ensure accurate and quick responses to an ethanol sample from a subject. The results from the BAS can mean the difference between criminal charges or not. Therefore, the repeatability and accuracy of the BAS is or paramount importance. Therefore, there is a great deal of focus on creating materials that are long lasting and can yield accurate and reliable results.

At the heart of the BAS is the proton exchange membrane (PEM) as seen in Figure 1. The PEM requires various characteristics to ensure adequate performance: high water-uptake, excellent conductivity and stability. Nafion is currently used in state of the art power generation fuel cells. With its excellent properties as a PEM for power generating fuel cells, it has been adapted for use in literature as the PEM for BASs in literature [1]. However it has not been widely used in commercial applications. Poly Vinyl Chloride (PVC) based materials impregnated with sulfuric acid are currently used in most state of the art commercial BASs. While PVC does show excellent conductive properties, it is known to dry out in low humidity environments [2], greatly affecting sensor performance. Consequently, there is a great desire to find alternative membrane materials for commercial devices.

We have evaluated BASs constructed with several different PEM materials that may be better suited to low relative humidity (RH) conditions. Figure 2 shows that at start-of-life, the membrane material plays little role in the performance of the BAS. Therefore, the work presented here will focus on membrane properties have the greatest influence on BAS sensor stability. In particular, how relative humidity, aging and severe operating conditions affects the performance of the BAS,.

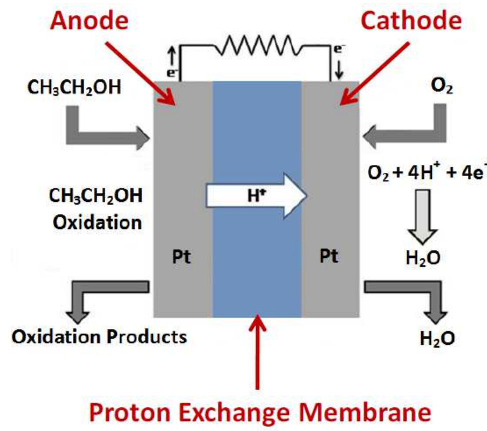

Figure 1. Diagram of fuel cell-based BAS.

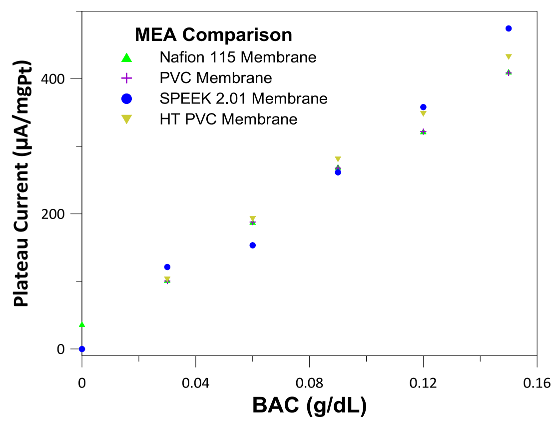

Figure 2. Sensitivity plot for various membrane materials. Anode and Cathode composed of 0.42 mg/cm^2 of Pt on ELAT cloth.

References

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