

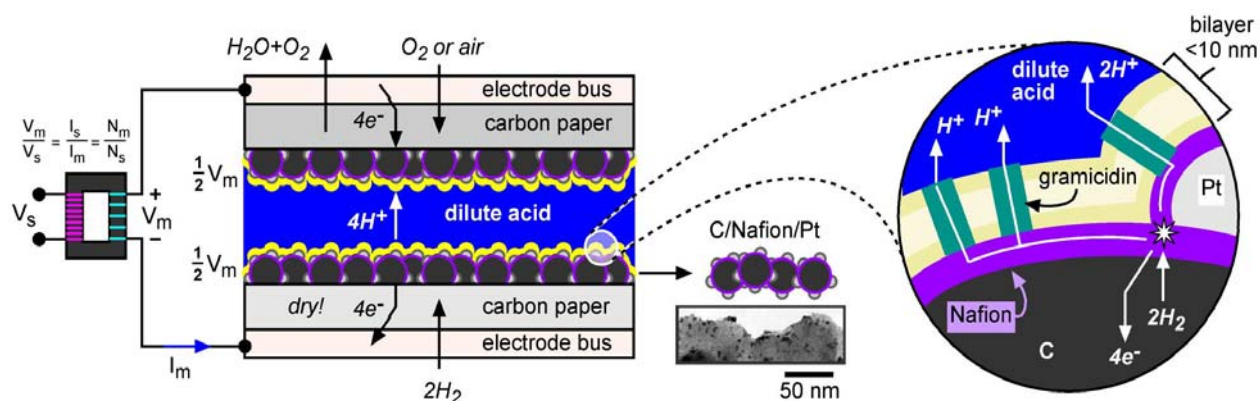
## Self-Assembled Bilayers for Ultra-High Conductance Proton Exchange Membranes

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**Objectives:** The primary objective of this research is to develop new approaches to fuel cell membranes that have very high rates of proton transport, three orders of magnitude higher than current Nafion® based fuel cells, and reduce co fouling by operation at elevated temperatures.

**Approach:** The membrane is composed of lipids or lipid like materials and is supported on a synthetic porous support, and this assembly contains pores that are selective for protons. The pores of the fuel cell membrane are composed a biological ion channel (gramicidin as one example) that works as a water wire. Water wires are responsible for the two to three order of magnitude rates of transport of protons in solution. When water wires are the conductors for protons in transmembrane biological transport proteins, they are responsible for the rapid rate of transport of protons across membranes. This proposal also attempts to reduce CO fouling by operation at elevated temperatures.

Our working group envisions that the bilayer approach can be built upon a slightly modified electrode film as Fig. 6. Standard PEM materials can be used with exception of the bilayer and its bonding to the electrode. Bonding of the electrode/bilayer can be achieved covalently via surface functionalization. Alternately, the electrode surface can be hydrophobized such that  $\frac{1}{2}$  of a bilayer (monolayer) self-assembles as a simple surfactant. For example, removing/replacing exposed sulphonate side-chains from an ultra-thin Nafion film can provide such hydrophobicity.



**Fig. 6.** Bilayer PEM covalently bonded to a C/Nafion/Pt electrodes similar to that presently in use for low-temp fuel cells.

Some of the advantages include use of conventional materials, inherent ability to form 3-phase contact, bilayer not exposed to formation of water, and possibility of self-repair. The processing of the proposed bi-layer will be done using carbon paper as support and nanoporous foam, screen-printing of electrode, functionalized bilayer, and dilute acid sandwiched between the layers.