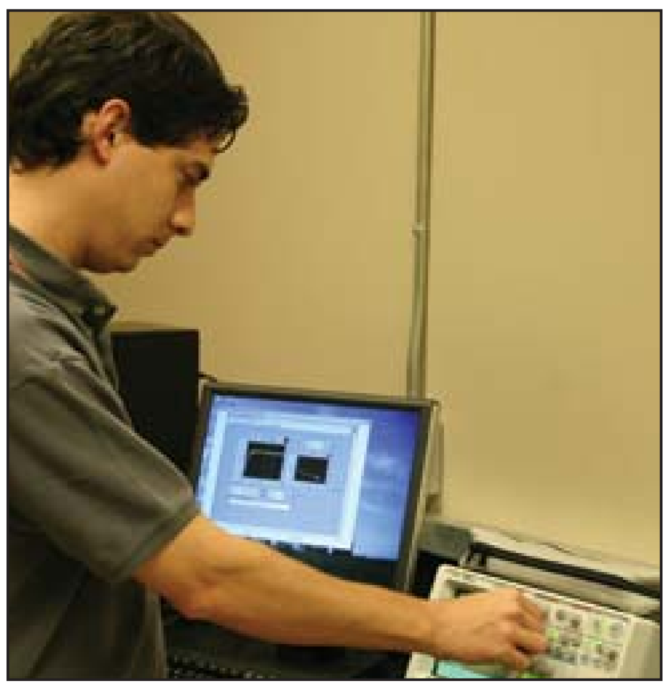
FUEL CELL DEVELOPMENT—Vijay Vajrala is currently enrolled in the UH doctoral program in physics and biophysics. He arrived at the university having earned his M.S. in physics and a B.S. in Mechanical Engineering from the University of Hyderbabal in India.

LIFE CELLS—D. Nawarathna is currently enrolled in the doctoral program in biophysics at the University of Houston. A member of Dr. Miller's research team in fuel cell research, Nawarathna earned his B.S. degree in mechanical engineering in his native country, Sri Lanka.

CLEAN ENERGY—Gustavo Cardenas, doctoral student in the Department of Physics, completed his undergraduate study at the Monterey Technological University (TESM), Mexico. His UH studies focus upon fuel cells combining oxygen and hydrogen as a clean energy source.



PHYSICS-BIOPHYSICS—Hugo Sanabria, doctoral student in physics/biophysics, is engaged in Dr. Miller's lab in dielectric spectroscopy for the study of life cells and proteins. He earned his B.S. degree in physics at the Monterey Technological University (TESM) in Mexico.

Fuel Cells for Space Applications

John H. Miller, Jr. [UH] / James R. Claycomb [Houston Baptist University]

PROJECTIONS OF THE DOMESTIC AND worldwide markets for electric power indicate the need for significant increases in power generating capacity. Fuel cells, which combine hydrogen and oxygen to produce electricity and water in an electrochemical reaction, hold promise as clean, efficient power sources. NASA first employed fuel cells to provide on-board power for the Gemini and Apollo spacecraft in the 1960s and, more recently, the Space Shuttle. Proton exchange membrane (PEM) fuel cells have advanced to the point of commercialization in the last decade. The Power Branch at Johnson Space Center (JSC) tests PEM fuel cells to determine life limits, establish voltage and current output stability, and determine performance requirements for reliable, safe operation.

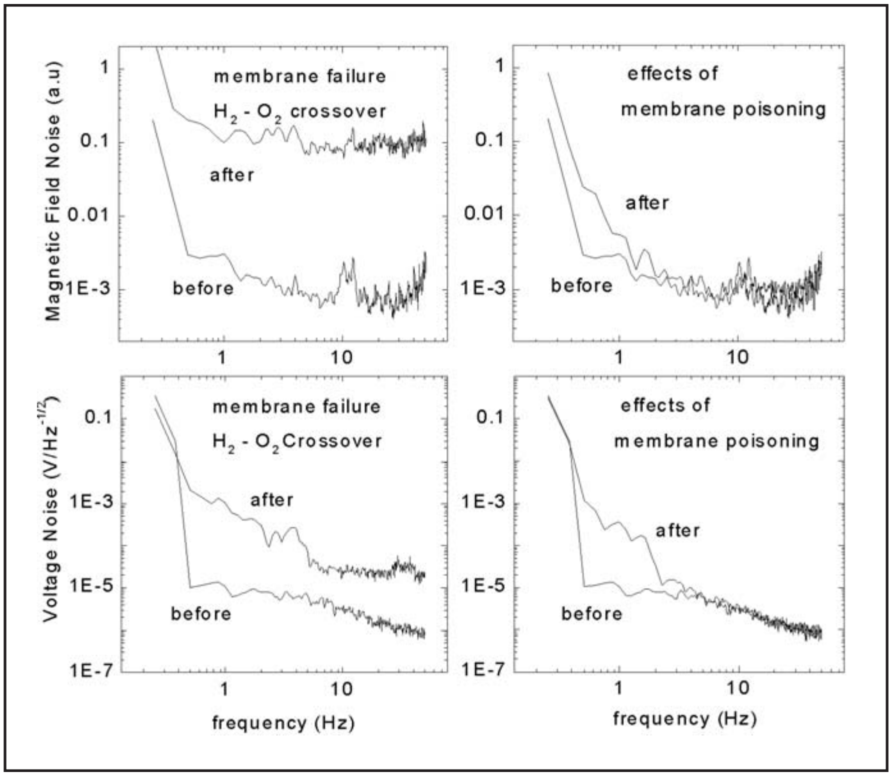


Figure 1. Electric and Magnetic Noise Spectra Recorded Before and After Membrane Poisoning and Membrane Failure Resulting in Fuel Gas Crossover. The magnetic noise spectra were recorded with a SQUID gradiometer (in collaboration with A. Brazdeikis; see publications). Both electric and magnetic noise spectra were obtained using a Stanford Research SR780 signal analyzer.

UH researchers have studied a unique approach to the study of PEM fuel cells—the use of sensitive magnetic sensors, known as superconducting quantum interference devices (SQUIDs). For example, we have found that frequency domain measurements enable detection of fuel gas crossover and membrane poisoning. Magnetic noise spectra have been observed to increase by roughly two orders of magnitude while the voltage noise increases roughly one order of magnitude during gas crossover. Noise measurements are probably best suited for on-site inspection because they are rapid, noninvasive and can be applied to individual cells in a stack.

Magnetic noise measurements can be made when it is not possible to make direct electrical contact with the cell. The ability to identify incipient failure mechanisms, including gas crossover, could prove to be a valuable non-destructive testing technique.

Publications

Claycomb, J. R., M. Nersesyan, D. Luss, and J. H. Miller, Jr. “SQUID Detection of Magnetic Fields Produced by Chemical Reactions,” IEEE *Transactions on Applied Superconductivity* 11.1 (2001): 863-66.

Claycomb, J. R., K. E. Bassler, J. H. Miller, Jr., M. Nersesyan, and D. Luss. “Avalanche Behavior in the Dynamics of Chemical Reactions,” *Physical Review Letters* 87 (2001) 178303-1-4.

Claycomb, J. R., A. Brazdeikis, M. Le, R. A. Yarbrough, G. Gogoshin, and J. H. Miller, Jr. “Nondestructive Testing of PEM Fuel Cells,” IEEE *Transactions on Applied Superconductivity* 13 (2003): 211-14.