

ponents of the original signal. The Fourier transform mathematics of this process show that the frequency spectrum of the sequence of digital samples consists of the original signal's frequency spectrum plus the spectrum shifted by all the harmonics of the sampling frequency. If the original analog signal is sampled in the conversion process at a minimum of twice the highest frequency component contained in the analog signal, and if the reconstruction process is limited to the highest frequency of the original signal, then the reconstructed signal accu-

rately duplicates the original analog signal. It is this process that can give birth to aliasing.

To illustrate, consider a time function signal consisting of two sinusoids, one at 25 Hz, and the other expected to be at 180 Hz. This sampling process uses a sampling frequency of 400 Hz (which is greater than  $2 \times 180$  Hz) and the reconstruction process has a bandwidth limit of 200 Hz. The only frequency components that will appear in the conversion are 25 Hz and 180 Hz. However, if the original signal's highest frequency is not the expected 180 Hz but 213 Hz, a reconstructed signal consisting

of 25 Hz and 187 Hz (400-213) will result. The 213-Hz signal component appears in the output as the 187-Hz component (187 Hz "alias" 213 Hz).

Since all signal conditioning modules that provide isolation typically use some form of analog sampling conversion process to move analog information across an isolation barrier, it is critical for system engineers to examine their application carefully to determine whether aliasing can occur.

*This work was done by Dataforth Corporation. For more information, visit <http://info.hotims.com/22914-122>.*

## Composite Bipolar Plate for Unitized Fuel Cell/Electrolyzer Systems

**A weight-saving design is applicable toward space missions, submarines, and high-altitude aircraft.**

*John H. Glenn Research Center, Cleveland, Ohio*

In a substantial improvement over present alkaline systems, an advanced hybrid bipolar plate for a unitized fuel cell/electrolyzer has been developed. This design, which operates on pure feed streams ( $H_2/O_2$  and water, respectively) consists of a porous metallic foil filled with a polymer that has very high water transport properties. Combined with a second metallic plate, the pore-filled metallic plates form a bipolar plate with an empty cavity in the center.

In electrolyzer mode, this cavity fills with water, which cools the stack, and provides the water for the electrolysis. The water passes through the polymer-filled pores under an RH gradient and feeds the electrolysis reaction. Under fuel-cell mode, the water is vacuumed out of the chamber with vacuum being continuously applied to remove water from the fuel-cell reaction. This evaporative cooling also provides heat removal from the stack.

At 80 °C, electrolyzer performance was superior to that of flowing water in the hydrogen chamber up to 400 mA/cm<sup>2</sup>. Above this current density, the membrane begins to dry out as water cannot be carried to the oxygen electrode fast enough. Similar behavior was seen when operating under fuel-cell mode. The current invention outperformed the traditional flow-through fuel cell up to 300 mA/cm<sup>2</sup>. Above this current density, the oxygen chamber begins to flood.

When operating in electrolyzer mode, the hybrid plate generates  $H_2$  and  $O_2$  at much lower water contents than traditional electrolysis cells. This greatly simplifies drying of the product gases. Because the water is the only product from the reaction, the feed gases can be operated under "dead-ended" conditions; thus, eliminating the need for saturation, recirculation, and water/gas separation systems for fuel-cell operation. In both fuel-cell and electrolyzer mode,

this advanced, unitized cell shows equal or superior performance to discreet systems. This design also allows for simple high-pressure operation with a high differential pressure.

Keeping all feed reactants and products in the vapor phase leads to a system simplification. This eliminates the biggest challenge to unitized systems (water management), allowing the weight savings of a second stack. A study has been carried out and has successfully demonstrated proof-of-concept. More design work has to be done to translate this concept into a full system.

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*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18269-1.*

## Spectrum Analyzers Incorporating Tunable WGM Resonators

**Resolutions would be much greater than those of current spectrum analyzers.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

A photonic instrument is proposed to boost the resolution for ultraviolet/optical/infrared spectral analysis and spectral imaging allowing the detection of narrow (0.00007-to-0.07-picometer wavelength resolution range) optical

spectral signatures of chemical elements in space and planetary atmospheres. The idea underlying the proposal is to exploit the advantageous spectral characteristics of whispering-gallery-mode (WGM) resonators to obtain spectral

resolutions at least three orders of magnitude greater than those of optical spectrum analyzers now in use. Such high resolutions would enable measurement of spectral features that could not be resolved by prior instruments.