

Background

Synkera Technologies, Inc. initiated development of solid-state, electrochemical sensors for carbon dioxide (CO₂) under a SBIR Phase I grant from NOAA. The targeted application was for use in closed-circuit rebreathers, but the sensor has relevance to numerous other applications. The sensor utilizes a solid polymer electrolyte and microelectrodes and is operated using short chronoamperometric pulses to differentially reduce oxygen (O₂) and CO₂, making the measurement of CO₂ possible.



Figure 1: Prototype sensor.

Preliminary Studies

Sensors were tested using a potentiostat and exposed to varying CO₂ concentrations in humid gas streams. A two potential pulse was used to first reduce O₂ in the gas stream, followed by a pulse for the detection of CO₂. The potentiostat was used to ensure the application of fast potential pulses with accurate and fast data recording. Potential pulse periods from 50 to 200 ms were examined.

A typical test showing the response of a sensor to changing gas conditions is shown in Figure 2. The sensor is held in air for 300 seconds, exposed to 2.5% CO₂ for 300 seconds, then returned to air for 300 seconds. The humidity is ~50% RH. The sensor response appears relatively slow because the sensor element is in a test jar and the concentration inside the jar takes time to change when the gas inlet is switched from air to CO₂ and back.

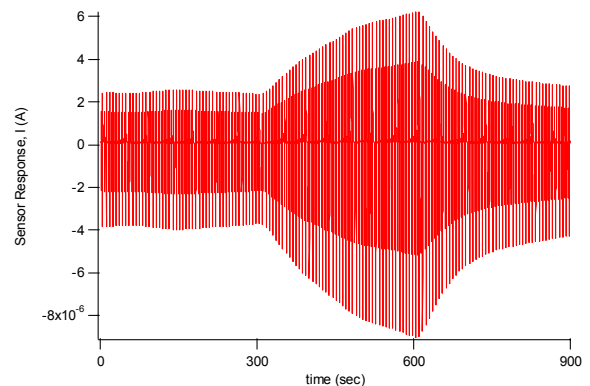


Figure 2: Sensor response to 2.5% CO₂ in humid air. CO₂ is introduced at 300 seconds and removed at 600 seconds.

Figure 3 presents the effect of the pulse length on sensor response. Following the example of Figure 2 the sensors were exposed to air and 1% CO₂ in a humidified gas stream. The peak sensor current is measured on the CO₂ pulse. The final current at the end of the pulse is also measured and the % response is reported. The sensor response is largest for the smallest pulse widths. It is seen that measuring the peak current results in a larger signal than measuring the final pulse current.

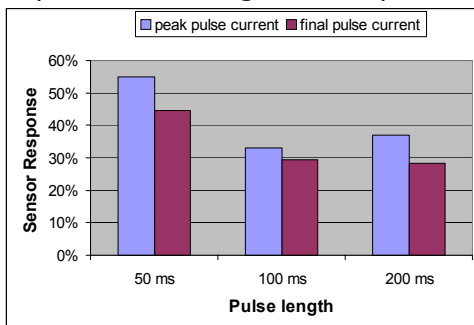


Figure 3: Sensor response to 1% CO₂ as a function of pulse time.

the all solid-state design ensures that pressure changes (rapid or not) will not damage the sensors. Because the sensors are partial pressure devices, the output as surface volume equivalent will vary with changing depth. However, the output can be corrected to an absolute value using pressure data.

Figure 4 shows the response of a sensor to both 1% and 2.5% CO₂, based on a 200 ms applied potential pulse. As expected, the response to 2.5% is larger than the 1% response.

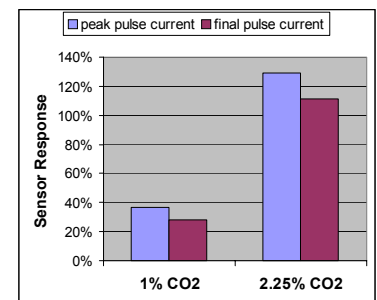


Figure 4: Sensor response to 1% and 2.5% CO₂. Pulse length is 200 ms



Targeted Specifications

Through the continued development of the solid-state electrochemical sensor the following performance is expected.

Range:	400 ppm – 10% CO ₂
Response Time:	< 60 seconds
Selectivity:	Minimum cross-sensitivity to common environmental species
Environmental Temperature Range:	-20° to 50°C
Environmental Humidity Range:	5% to 95% RH (non-condensing)
Power Consumption:	< 1 mW

Continued Development

Through the Phase I funding from NOAA the feasibility of the CO₂ sensor was established. The continued development of the sensor includes the following tasks and estimated timeline for each task.

- Development and fabrication of microcontroller based custom electronics to operate sensors in rapid pulse mode – 2 months
- Further sensor development – 4 months
- Complete sensor evaluation (including limited long-term testing) – 3 months

About Synkera Technologies, Inc.

Synkera Technologies Inc., based in Longmont, Colorado, develops and manufactures products utilizing nanotechnology, microfabrication and advanced materials engineering. Synkera provides innovative solutions for our customers. We produce nano/micro-structured materials, components and devices focusing on chemical sensors, ceramic membranes, hydrogen purification for alternative energy sources and opto-electronics. Synkera's unique combination of proprietary processes, precision engineering and integration of advanced materials into devices brings practical products to the market for everyday use.

Contact Information

For more information, please visit the company web site at www.synkera.com, or contact Debra Deininger at ddeininger@synkera.com or by phone at 720-494-8401 x105 for further information.