Agricultural Ammonia Sensor

TECHNOLOGY PROFILE

Synkera is developing solid-state ammonia sensors for a wide range of applications requiring rugged performance and continuous exposure to low ammonia levels. Of particular interest are agricultural applications, such as monitoring ammonia levels in animal housings. These chemiresistive sensors have a large positive response (resistance increase) when exposed to ammonia. The sensors operate reversibly at ambient temperature, but require an occasional heater pulse to fully desorb contaminants, in order to improve long-term performance. The sensor chemistry and mode of operation allow the sensor to be continuously exposed to ammonia, and handle over range concentrations, without degrading performance. Synkera's anodic aluminum oxide (AAO) MEMS microsensor substrate minimizes power consumption and supports rapid heating and cooling, due to the low mass and isolation of the sensing substrate. This novel ammonia sensor is packaged on a TO-39 electronic header, similar to Synkera's commercially available metal oxide sensors. The continuing development effort is funded by the USDA's SBIR program.

Prototype sensors have been evaluated in Synkera's laboratory. This testing was based upon the ISA standard, and includes sensitivity, linearity, response time, selectivity, effects of environmental humidity, and effects of environmental temperature. The sensors are very sensitive and selective. Table 1 shows the expected values to be used for the heater pulse cycle. Two potential performance issues that are being addressed are the high resistance of the sensor, particularly at high ammonia concentrations, and the effect of humidity on the sensor.

In addition to the laboratory testing at Synkera, the University of Kentucky has performed experiments with the sensor both in a laboratory environment and inside broiler chicken housings. These evaluations were performed alongside a photoacoustic analyzer. Photoacoustic analyzers are used as the "gold standard" for making measurements of ammonia levels in agricultural settings. Iowa State University will be performing sensor evaluations in layer chicken housings during the spring and summer of 2008. The information gained through these evaluations is guiding the continued development of the sensor for use in animal housings.

Synkera expects to release prototype sensors to select customers for evaluation in the spring of 2008, with full market introduction in 2009. For more information regarding these sensors, please contact Synkera:

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Table 1: Preliminary specifications for agricultural ammonia sensor.

Heater resistance	8-12 Ω
Resistance in air (50% RH)	5-10 MΩ
Resistance in 20 ppm NH_3 (50% RH)	20-40 MΩ
Heater pulse input	1 VDC
Heater pulse time	1 second
Power consumption	~10 mW (ave.)
"Sensing" time (between heater pulses)	9 seconds

Figure 1: Agricultural ammonia sensor packaged on a TO-39 header.

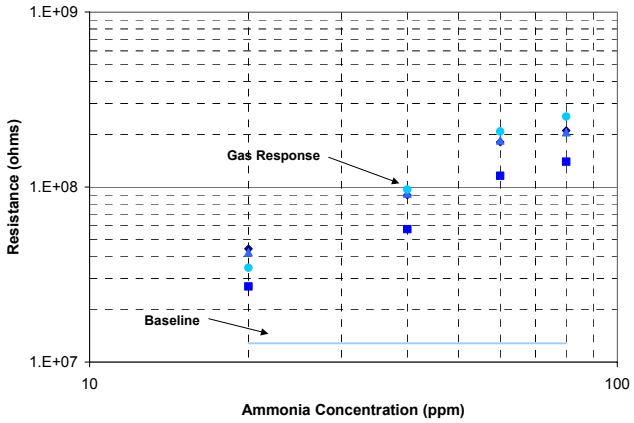

Figure 2: Data is shown for four ammonia sensors. Log (resistance) is proportional to log (concentration). A linear curve fit yields a r^2 value >0.98 for each sensor.

Table 3: Repeatability – The sensor response is highly reproducible. Variation in calibrated output (ppm equivalent) is within 10% of average.

	Exposure 1	Exposure 2	Exposure 3	Ave.
Sensor 1	90	89	81	87
Sensor 2	86	84	81	84
Sensor 3	91	91	82	88
Sensor 4	94	88	80	88

Table 2: The sensor is very selective toward ammonia relative toward other common interferents.

Gas	ppm equivalent
Carbon Dioxide – 5000 ppm	0.4
Carbon Monoxide – 50 ppm	0.1
Methane – 500 ppm	0.2
Propane – 200 ppm	0
Methanol – 50 ppm	0
Ethanol – 50 ppm	0.3
NO – 20 ppm	-3
NO_2 – 20 ppm	-3
N_2O – 20 ppm	0

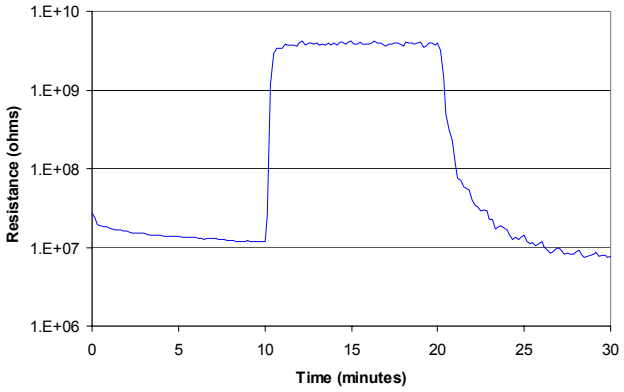

Figure 3: Over-range - Sensor exposed to 1000 ppm ammonia at 10 minutes, gas removed at 20 minutes. The sensor is not harmed by the high concentration of ammonia and the recovery is complete and fast.

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