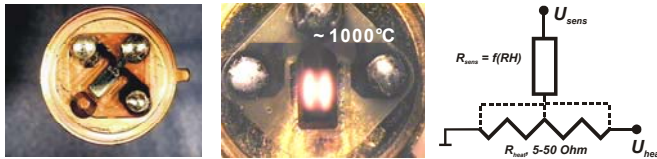


### OVERVIEW

The featured humidity sensors are based on our patented microsensor platform technology. The sensors are produced from self-organized nanostructured aluminum oxide and are designed to perform in many environments where conventional RH sensor can not operate reliably or have a limited lifetime. Their advanced performance is enabled by two technological innovations: (1) uniquely engineered morphology and chemistry of ceramic sensing material at the nanometer scale provides a foundation for enabling its superior humidity sensing characteristics; (2) micromachining of alumina provides a miniature low power sensor design that supports sensor regeneration and new operating modes.



Packaged RH sensor and its equivalent circuit

### SENSOR FEATURES:

#### Durability and Regeneration Capability

The sensors are mechanically robust and can operate in a broad temperature range, from as low as  $-60^{\circ}\text{C}$  to as high as  $500^{\circ}\text{C}$ . Sensors can be regenerated from wetting, are resistant to environmental contamination and withstand direct contact with chemicals that foul polymer sensors.

#### High Sensitivity

Good sensitivity and log-log linearity was demonstrated in broad humidity (0.25 – 95%RH) and temperature ( $-15$  –  $+30^{\circ}\text{C}$ ) ranges. Sensors with chemically modified alumina showed detection of as little as 10 ppm of water vapor.

#### Short Response/Recovery Time

The sensors have rapid response (1-10 seconds at  $25^{\circ}\text{C}$ , 15-60 s at  $-15^{\circ}\text{C}$ ) and recovery (3-15 s at all temperatures).

#### Repeatability

The sensors exhibit reproducible response, stable baseline, excellent signal-to-noise ratio and long lifetime.

#### Low Power Consumption.

Less than 100mW in *t-pulse* mode,  $\sim 1$  mW in *passive* mode.

#### Manufacturability.

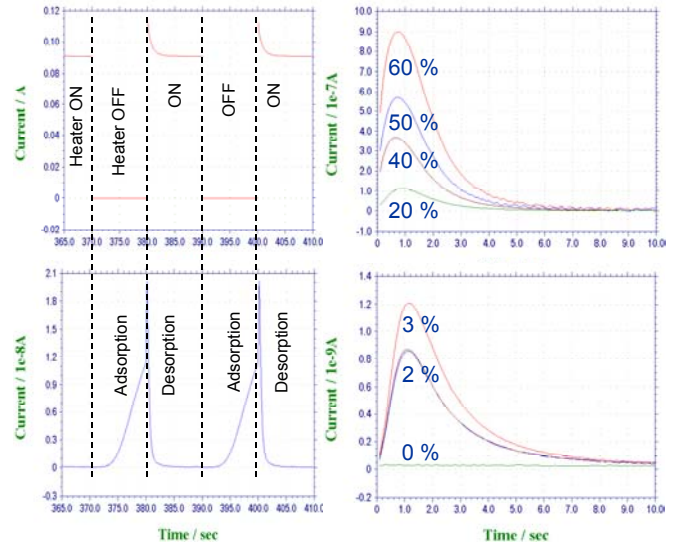
The technology is scaleable, supports multiple packaging options and is cost-competitive.

### OPERATING MODES

Two operating modes are supported: “passive” mode (no heating), and “*t-pulse*” mode (periodic heating). In both cases, a constant voltage is applied to sensing electrode and the current or resistance is measured. A typical measurement profile in a *t-pulse* mode includes 2 cycles:

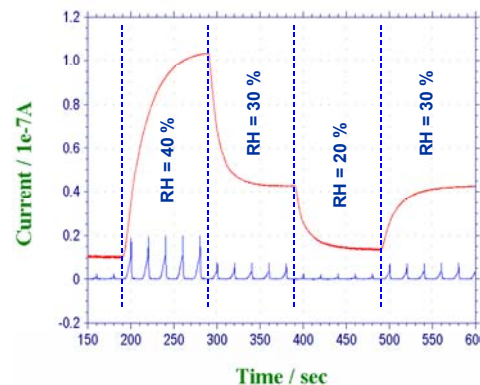
- adsorption cycle (heater off) to allow water molecules to adsorb onto the sensing element (2-100 s, depending on desired sensitivity).
- desorption cycle (heater on) to evaporate water molecules from the sensing element ( $150^{\circ}\text{C}$ , 5-15 s).

During the desorption cycle a quick rise in current is observed. The desorption current peak yields a highly reproducible measurement for a given RH level and adsorption cycle duration.

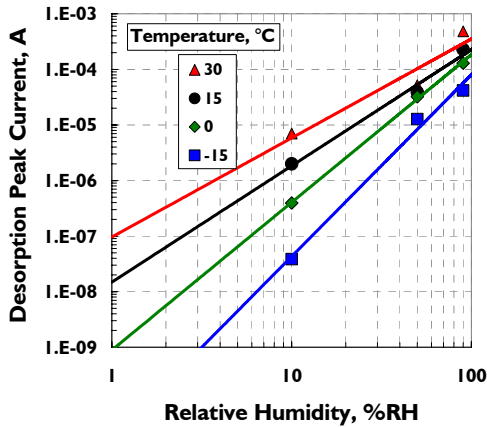


T-pulse mode at 40% RH (10s pulses,  $25^{\circ}\text{C}$ )

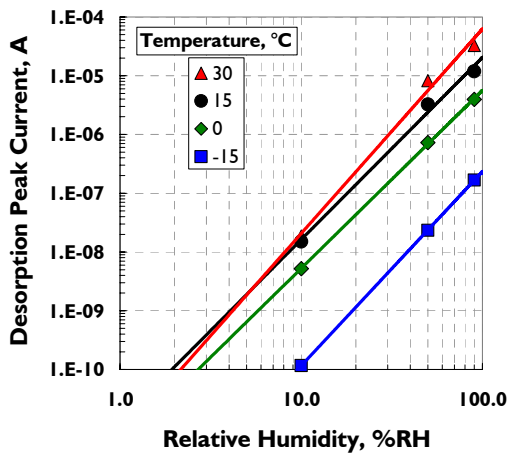
Desorption peaks for different RH ( $25^{\circ}\text{C}$ ).



Typical sensor response to RH changes in passive (red) and T-pulse (blue) modes.



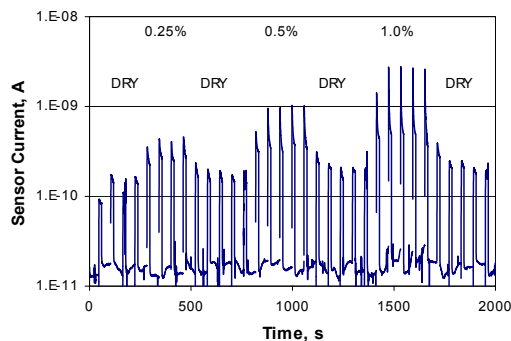
Non-modified sensors in *t*-pulse mode at 240 sec cycle.



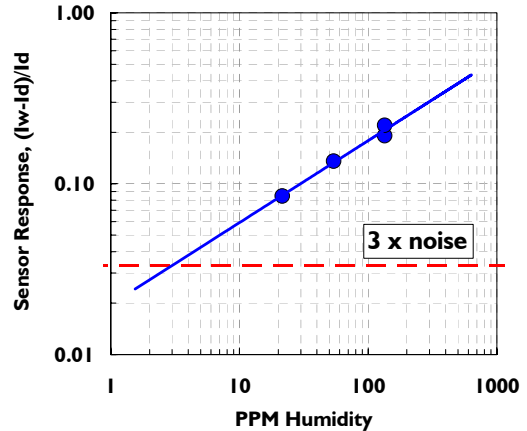
Non-modified sensors in *t*-pulse mode at 30 sec cycle.

### NEXT GENERATION LOW PPM SENSORS

For the detection of low humidity levels, additional chemical modification of the sensing element is performed. Sensors modified in such fashion exhibited much stronger and faster response in comparison with unmodified sensors.



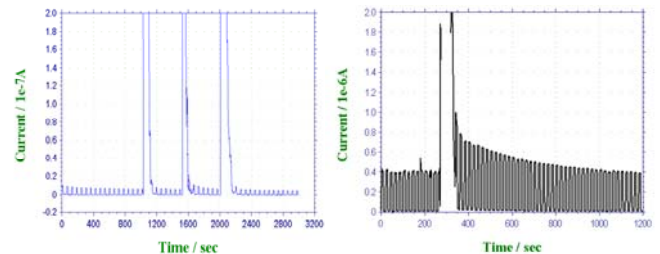
Response of modified sensor in *t*-pulse mode at 25°C



Modified sensor in *t*-pulse mode at 25°C.

### REGENERATION CAPABILITIES

The sensors demonstrated robust recovery from wetting and contamination by a number of chemicals that could be burned out during the high temperature cycle. This procedure could be constantly enabled in the *t*-pulse mode, or could be applied periodically in a *passive* mode.



Sensor current recovery in *t*<sup>o</sup>-pulse mode after sprays of water (left) and antifreeze (right) were applied.

Many application opportunities exist for the featured humidity sensors. We are currently targeting applications that require low-cost, low-power, high sensitivity, fast response, reliable and robust humidity sensors that can operate in a variety of environmental conditions, have a broad temperature range and could be regenerated from contamination and wetting.

Joint development partnerships are being sought to further advance and qualify the featured humidity sensor technology for a wide range of applications. Areas of potential collaboration include specific application development, field-testing, instrument integration, and market introduction. *Synkera Technologies* strives to be customer oriented. If you have a special application you would like to discuss, or questions you would like answered please contact us at [info@synkera.com](mailto:info@synkera.com).