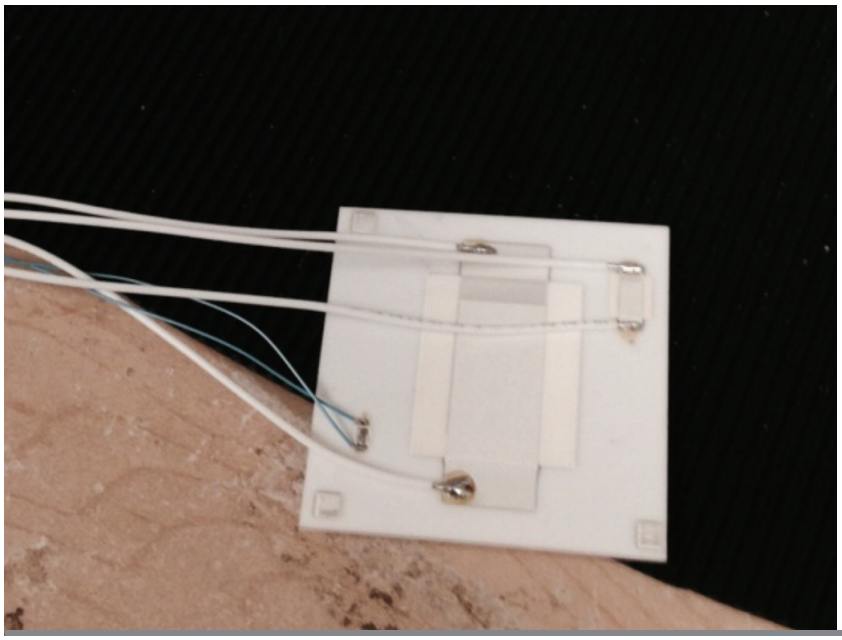


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Sensors

Novel Solid-State Humidity Sensor

Unparalleled sensitivity, response, recovery time, and robustness

NASAs Marshall Space Flight Center has developed a humidity sensor that offers high sensitivity and extremely fast response and recovery across a range of humidity levels. The sensor is based on a novel ceramic dielectric material that exhibits rapid and large changes in capacitance and resistance with very small changes in water vapor concentration; making it ideal for humidity, dew point, or water vapor concentration sensing applications.

The dielectric sensing element is low-cost and can easily be made using standard printed electronics processing and packaging methods. The finished sensor is small and robust, and can be used to for rapid measurements of very small changes in humidity across a range of humidity levels, temperatures and chemical environments. The humidity sensor technology is particularly well suited for market applications requiring extremely high sensitivity, fast response times, and/or use in challenging environments. NASA is currently seeking partners to bring this novel sensor technology to the marketplace.

BENEFITS

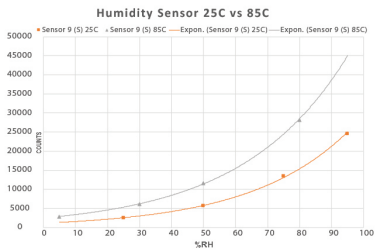
- Very high sensitivity to small changes in relative humidity, dew point, and water vapor concentration
- Nearly instantaneous response and recovery speeds
- Robust solid-state sensor can operate in challenging temperature, humidity and chemical conditions
- Low voltage and power operation
- Small form factor
- Flexibility in dielectric ceramic powder formulation that enables the use of a variety of thick film and advanced printed electronics manufacturing methods

THE TECHNOLOGY

NASAs novel ceramic dielectric material enables extremely high-sensitivity humidity sensing. The ceramic sensing element is robust, can be manufactured using printing processes, and exhibits fast response and recovery speeds with large capacitance and resistance response/change per relative humidity unit change across a wide range of humidity levels in a log-linear response. Preliminary test data conducted in a humidity test chamber show a log-linear measured response in capacitance from 5 nanofarads (at 30% relative humidity, room temperature) to 0.2 millifarads (at 90% relative humidity, room temperature).

The inventors discovered the humidity sensing element technology during their efforts to develop next-generation energy storage materials and devices for NASA. The inventors were initially puzzled by large swings in capacitance observed over the course of any given day in one particular dielectric composition, and, ultimately, they were able to trace these unexpected changes in capacitance back to corresponding changes in ambient humidity, even those occurring from breathing and exhalation.

The sensor element can be formed using a dielectric ink or paste formulation, also developed by NASA, via traditional screen printing or advanced ink jet, aerosol, or 3D printing methods. The printed sensor element can be very thin, on the order of microns in thickness, with a small footprint, one square centimeter or less.



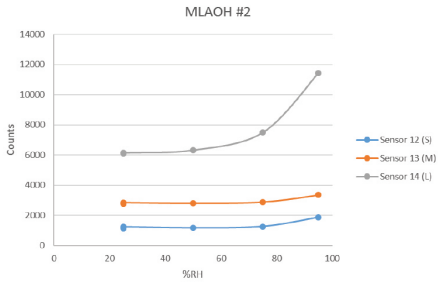


FIGURE - (left) Sensor shows similar response at 25C and 85C for easy calibration (right) Three curves showing complete data from sensors of different sizes repeatedly cycled up and down from 25 - 95% RH, demonstrating perfect repeatability for each sensor without any hysteresis effects.

APPLICATIONS

The technology has several potential applications:

- Aerospace
- Automotive
- Industrial
- Health care
- Marine
- Consumer
- Defense

PUBLICATIONS

Patent No: 9,987,658

-Hanekom, K. R., and T. D. Rolin. "Fabrication and Testing of a Novel Ceramic-Based Additively Manufactured Humidity Sensor." (2022)

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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More Information

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