Polythiophene-Based Gas Chemical Sensors for Detecting End-of-Service-Life of Respirator Filter Cartridges

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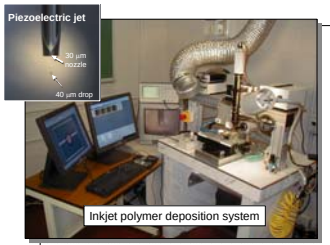
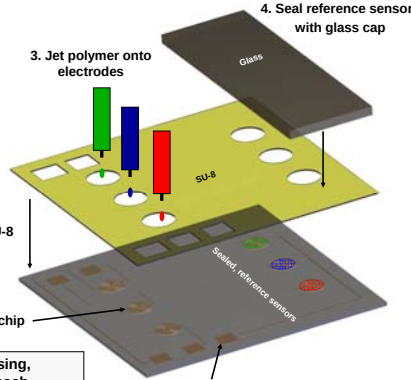
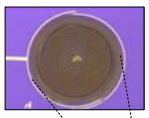
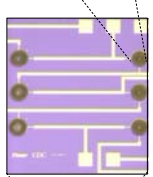
Sensor Chip






P3HT inkjetted onto spiral electrode

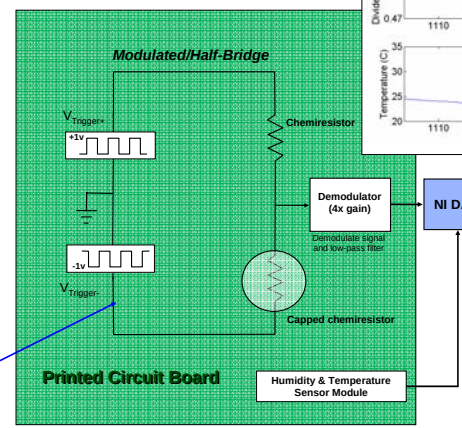

3 sensor electrode pairs

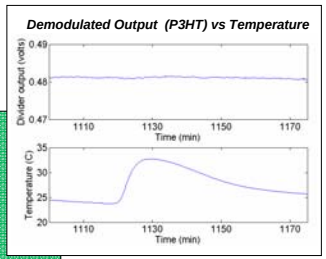

Sensor chip mounted in T0-5 package

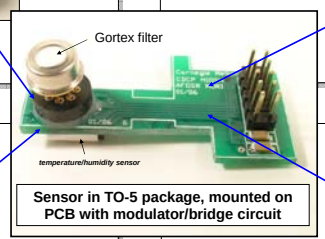
A sensor chip, packaged in a T0-5 housing, incorporates 3 matched sensor-pairs, each fabricated with a different polythiophene-based polymer. Each sensor pair includes one device that exposed to analytes, and one capped device to act as a reference in a bridge circuit to minimize sensitivity to temperature variations. An SU-8 layer facilities capping, and also seals exposed gold traces against humidity.

Sensor Circuit

The TO-5 sensor package is mounted on a PCB containing sensor conditioning circuitry and a humidity & temperature sensor module. Matched sensor pairs are configured in a half-bridge to cancel common-mode temperature variations. The bridge is driven by a 100 Hz square wave, and the bridge output is demodulated to reject baseline sensor drifts (measured as 0.9%/day for P3HT divider). The output of the demodulator, which is amplified and filtered, and the outputs of the temperature/humidity sensors are interfaced to PC through a NI AD card. The data is captured and further processed by LabView.

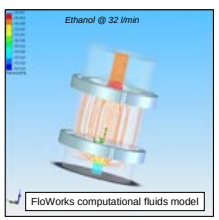


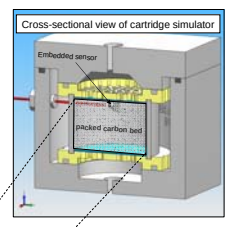


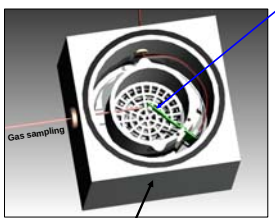


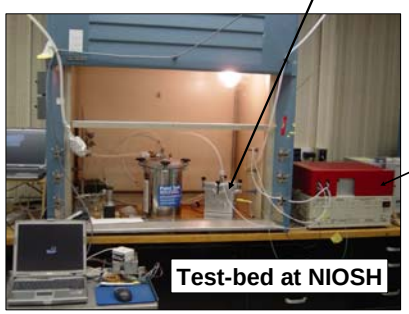
Sensor in TO-5 package, mounted on PCB with modulator/bridge circuit

Cartridge Simulator Test-Bed





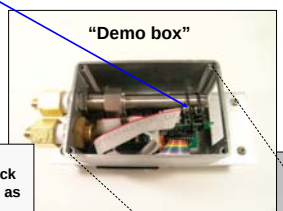


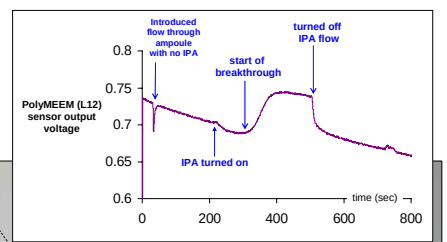


Gas Chromatograph

A cartridge simulator test-bed has been developed to systematically evaluate sensors embedded within carbon filter beds. Gas analyte concentrations can be measured at specific locations in the beds using an adjustable gas chromatograph sampling tube. Computational fluid models can predict flow patterns to help predict expected distributions of analytes throughout the powder bed.

Preliminary Testing





A "demo box" system was developed for quick screening studies and as a portable system to demonstrate the sensing technology to industry, on site, or in the field.

Air is bubbled through liquid analyte, and the resulting gas is mixed with air. The mixture is flowed through a carbon containing glass ampoule, as a surrogate filter, and the outlet flow is channeled over the TO-5 sensor package. A NI USB AD converter interfaces the sensor board output a laptop PC running LabView.