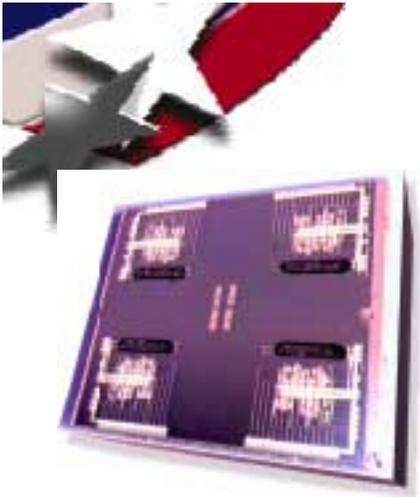
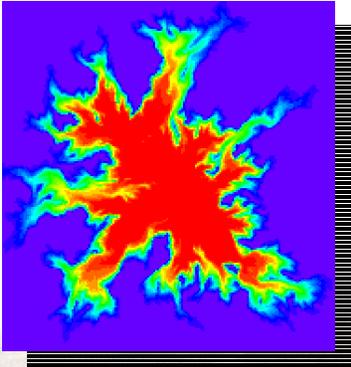


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Microchemical Sensors for In-Situ Monitoring and Characterization of Volatile Contaminants



C. K. Ho, R. C. Hughes, M. W. Jenkins, D. A. Lucero,
M. T. Itamura, M. Kelley

*Sandia National Laboratories
Albuquerque, New Mexico
Telephone: (505) 844-2384
E-mail: ckho@sandia.gov*

P. Reynolds

*Team Specialty Products
Albuquerque, New Mexico*

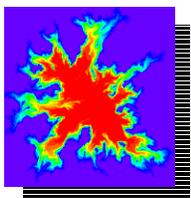




Overview



- **Background**



- **Microchemical Sensor & Packaging**
- **Data Interpretation & Characterization**



- **End Product**



Background

- **Tens of thousands of contaminated sites exist in the U.S. and in DOE complexes**
 - Many require long-term monitoring to ensure public safety
- **Over two million underground storage tanks containing volatile contaminants are being regulated by EPA**
 - 40 CFR Part 280 requires monitoring to detect leaks from tanks and associated piping





Problem

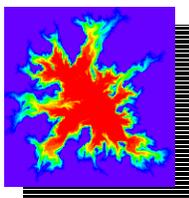
- **Current monitoring methods are costly, time consuming, and may not be representative of in situ conditions**
- **Need integrated system for inexpensive, robust, in-situ sensing of a variety of chemicals in geologic environments for long-term applications**
 - **microsensors**
 - **packaging and emplacement**
 - **data acquisition**
 - **data interpretation**



Overview



- Background



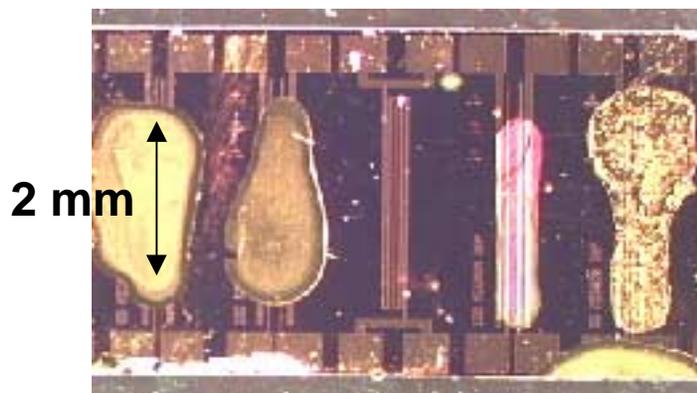
- **Microchemical Sensor & Packaging**
- Data Interpretation & Characterization



- End Product



Chemiresistor Sensors



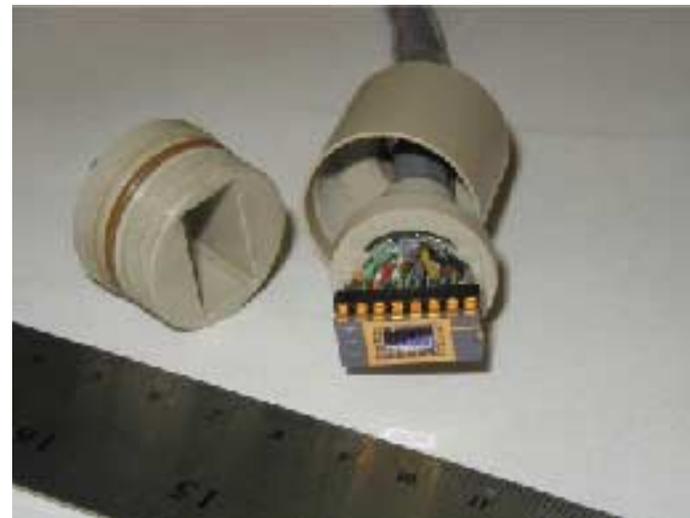
Chemiresistor Array
(4 Different Polymer Films)

- **Continuous in-situ monitoring of volatile organic compounds (toxic chemicals, explosives, etc.)**
 - **Polymer film with conductive particles forms chemically sensitive resistor**
 - **Vapor absorption causes reversible polymer swelling, changing electrical resistance**
 - **Extremely small, low-power system with no pumps or valves**
 - **Sensor array can provide analytic discrimination**



Chemiresistor Package

- **Designed and fabricated robust sensor package for deployment in monitoring well or cone penetrometer**
 - **Waterproof housing with Gore-Tex® membrane to allow vapor sensing**
 - **PEEK material is chemically inert, durable, and corrosion resistant**
 - **Modular design allows easy assembly and exchange of components**





Field Demonstration

Testing Chemiresistor Sensor Package in Monitoring Well (D3)



**Chemical Waste Landfill
Sandia National Laboratories
Albuquerque, New Mexico**

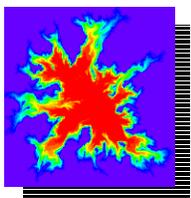
May 31, 2001



Overview



- Background



- Microchemical Sensor & Packaging

- **Data Interpretation & Characterization**



- End Product

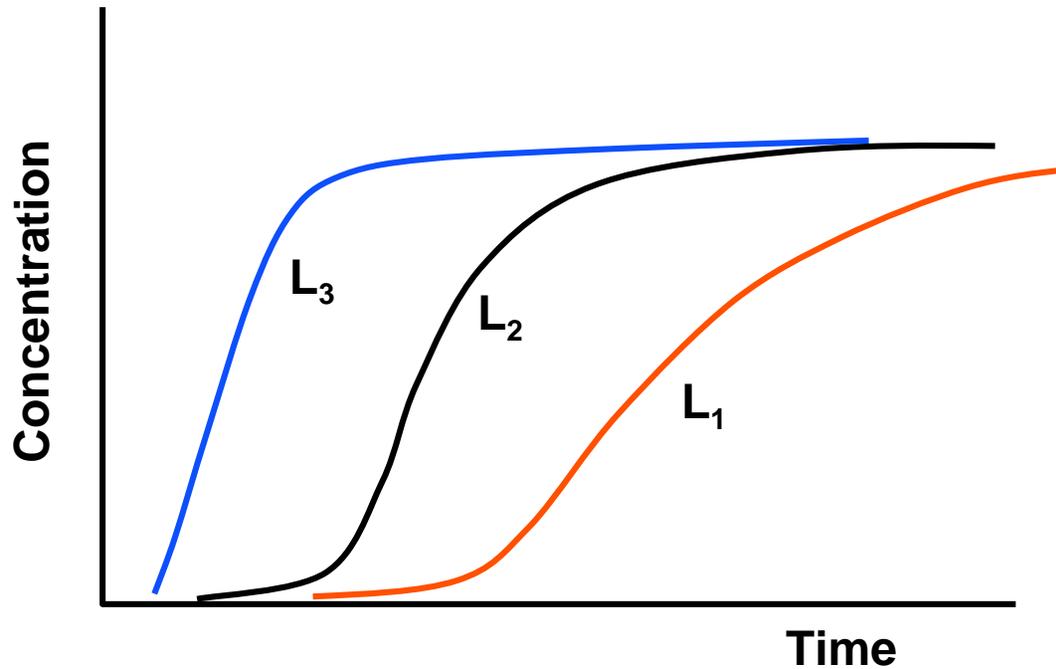
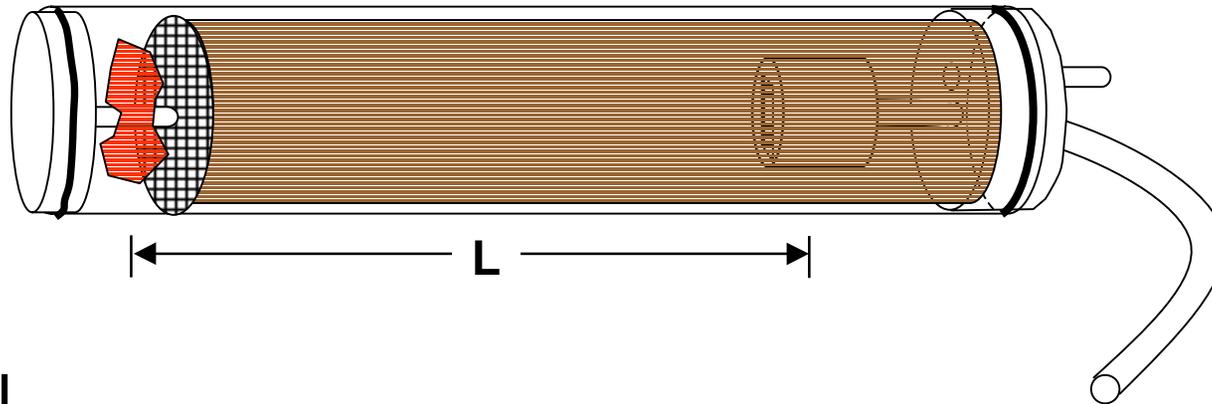


Data Interpretation and Characterization

- **Use in-situ sensor data to assist in characterizing contaminant**
 - **Location**
 - **Identification (composition)**



Determine Contaminant Location

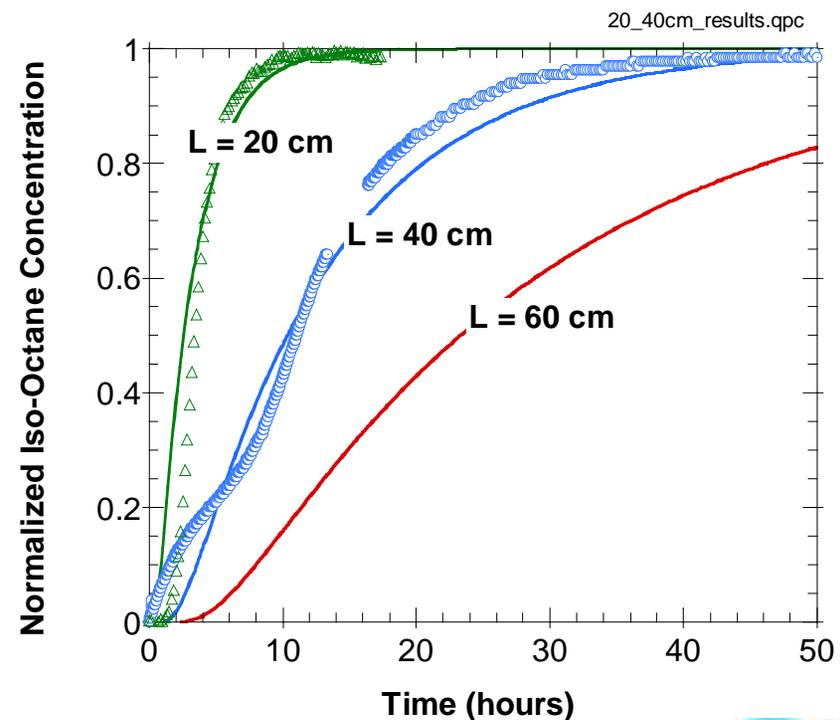


Compare sensor data with model predictions to determine distance from contaminant



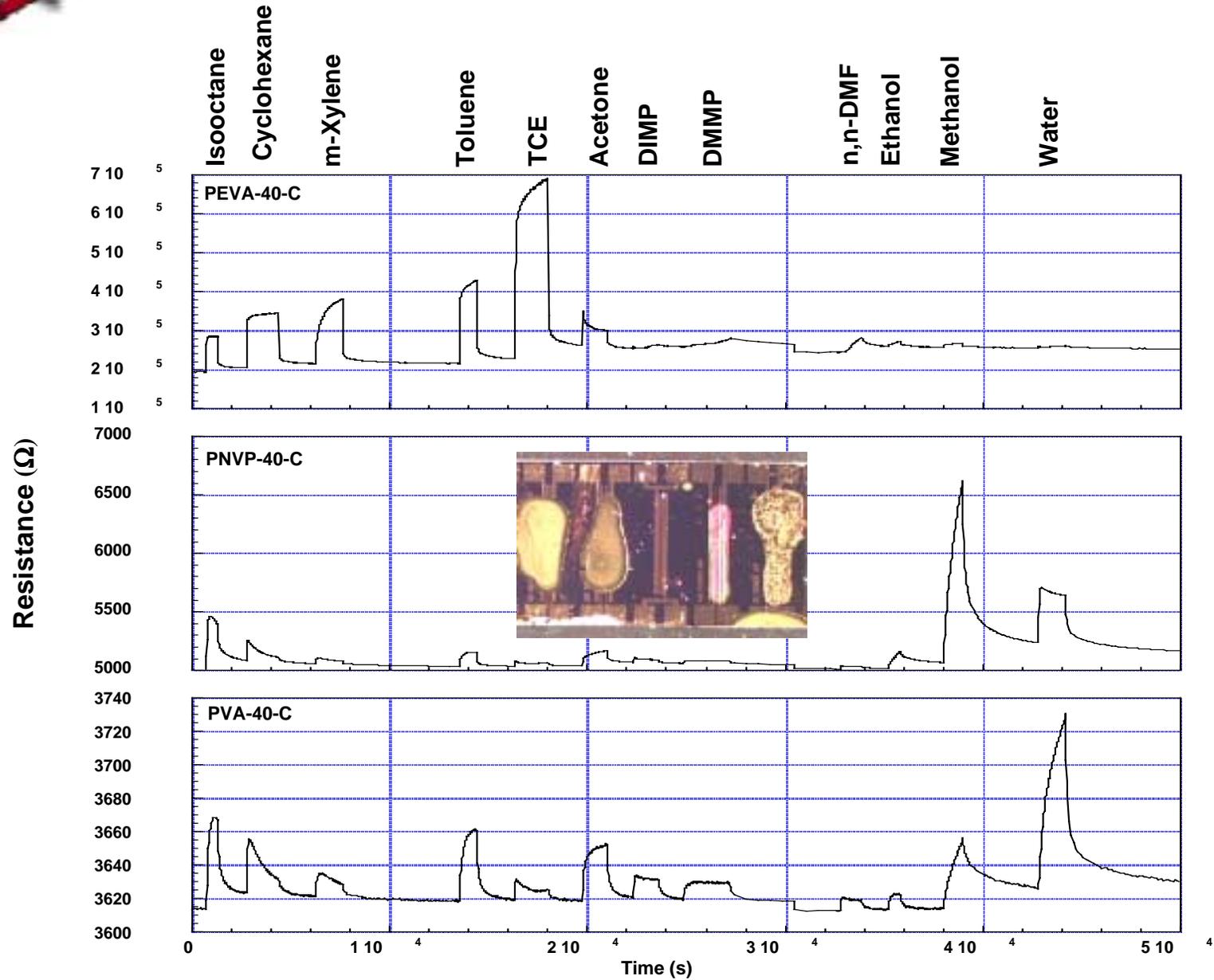
Experiments

- Designed 1-D experiments to test chemiresistor sensor package and characterization methods
 - Placed iso-octane boundary at varying distances from sensor
 - Compared data to model predictions at various distances





Contaminant Identification

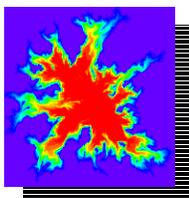




Overview



- Background



- Microchemical Sensor & Packaging
- Data Interpretation & Characterization



- **End Product**



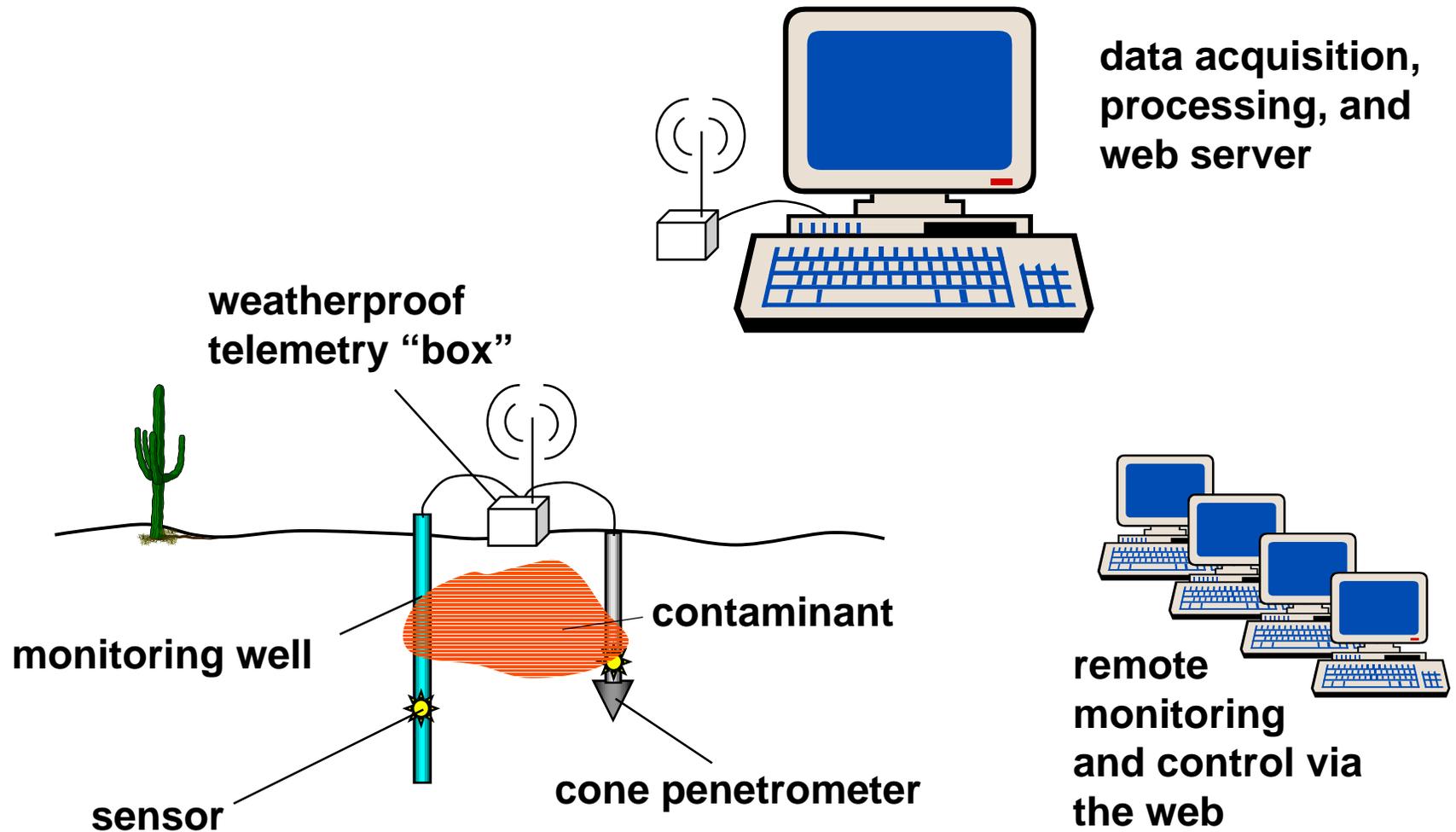
End Product (1 of 2)

- **Chemiresistor sensor package and integrated monitoring system that can be deployed in geologic (or other in-situ) environments**
- **Improved understanding of in-situ sensor behavior in geologic and groundwater environments**
- **Improved sensitivity and discrimination capabilities for existing sensors**





End Product (2 of 2)

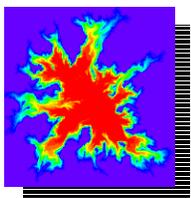




Summary



- **Background**



- **Microchemical Sensor & Packaging**
- **Data Interpretation & Characterization**



- **End Product**

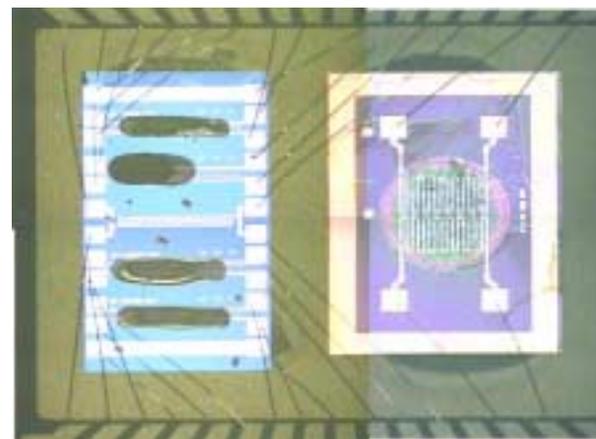


Backup Slides



Sensitivity

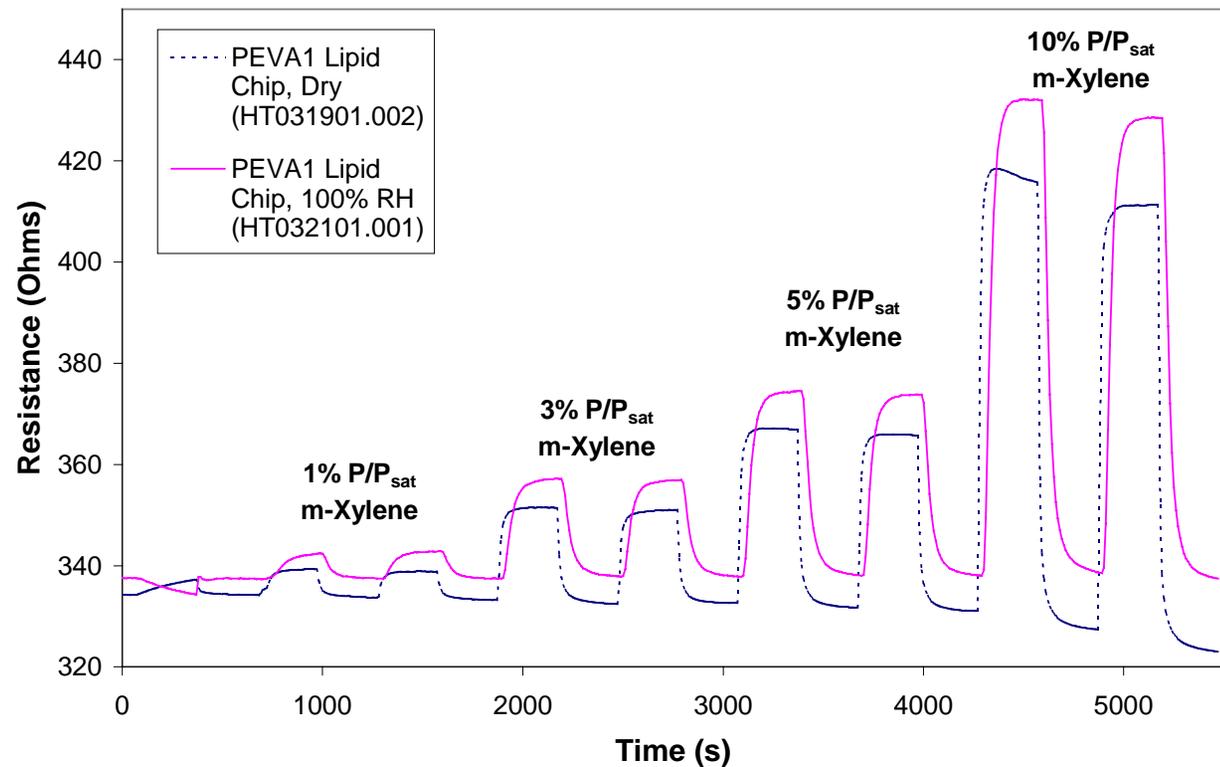
- **Current chemiresistors can reliably detect $< 1\%$ of saturated vapor pressure**
 - For xylene, this is equivalent to ~ 1 ppm by mass in water, which is below EPA drinking water standards
- **Integrated pre-concentrator can increase sensitivity by an order of magnitude**





Impact of High Humidity

- Performed calibration of chemiresistors at high humidity levels
- Results indicate detection of m-xylene in water at 2 ppm (EPA limit is 10 ppm)





Field Test Demonstration

