Sandia National Laboratories—LDRD Fact Sheet

Title: **Micro-Chemical Sensors for In-Situ Characterization and Monitoring of Volatile Contaminants**

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Duration: 3 years; began FY01

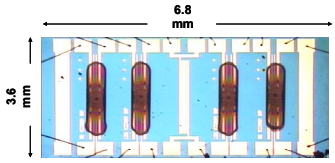
Web Site: http://www.sandia.gov/sensor (pictures, video, reports, links)

Problem Statement:

Manual soil sampling, such as this hand auger method at DOE Savannah River Site, can be time consuming, labor intensive, and costly.

- Tens of thousands of sites containing toxic chemical spills, leaking underground storage tanks, and chemical waste dumps will require characterization and long-term monitoring to reduce health risks and ensure public safety.
- Over a million underground storage tanks containing hazardous (and often volatile) contaminants are being regulated by the EPA, and the tanks require some form of monitoring to detect leaks from the tanks and pipe network.
- Current methods are costly and time intensive, and limitations in sampling and analytical techniques exist. Looney and Falta (2000, Ch. 4) report that the Department of Energy (DOE) Savannah River Site requires manual collection of nearly 40,000 groundwater samples per year, which can cost between $100 to $1,000 per sample for off-site analysis.
- Wilson et al. (1995, Ch. 36) report that as much as 80% of the costs associated with site characterization and cleanup of a Superfund site can be attributed to laboratory analyses. In addition, the integrity of the analyses can be compromised during sample collection, transport, and storage.

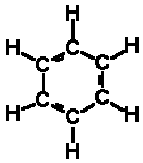
Objectives:



Chemiresistor array developed at Sandia National Laboratories with four different conductive polymer films deposited on different electrodes to discriminate among multiple analytes..

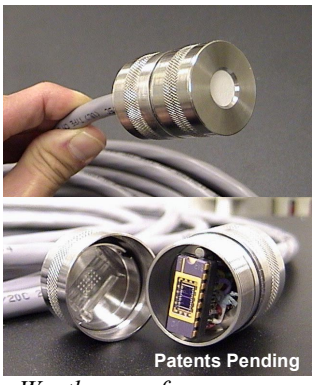
- Develop microsensors (chemiresistors) and integrated monitoring system that provide real-time, in-situ analyses of volatile organic compounds (VOCs).
- Develop polymer arrays and investigate microsystems with integrated pre-concentrator for enhanced detection capabilities.
- Develop robust packaging system that allows the sensor to operate in wet or dry subsurface environments.
- Develop novel characterization methods using in-situ data and predictive process models of contaminant transport.
- Understand impacts of subsurface environment (e.g., heterogeneities, moisture content, temperature) on sensor data and interpretation.
- Demonstrate data acquisition, data interpretation, and data processing using controlled laboratory experiments and field tests.
- Investigate remote sensing capabilities.

Chemicals Detected:



- Volatile organic compounds: aromatic hydrocarbons (e.g., benzene, toluene, xylenes); chlorinated hydrocarbons (e.g., TCE, carbon tetrachloride), aliphatic hydrocarbons (e.g., hexane, octane), alcohols, ketones.

- Sensitivity: Without preconcentration, the chemiresistors can generally detect vapor concentrations that are 1/1000th the saturated vapor concentration (Henry's law can be used to convert vapor concentration to equilibrium aqueous concentration). For example, for *m*-xylene, we have reliably detected a vapor concentration of ~100 ppm, which corresponds to ~1 ppm in the aqueous phase (EPA drinking standard for *m*-xylene is 10 ppm).

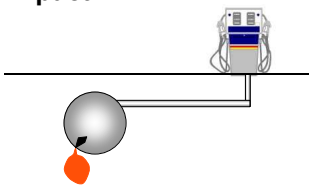


Weatherproof sensor package. The unique design and GORE-TEX® membrane allows the enclosed chemiresistors to "sniff" chemicals in air, soil, and water environments.

Collaborations:

- Field Demonstrations: Nevada Test Site—Advanced Monitoring Systems Initiative (EM-50); Chemical Waste Landfill (SNL); Edwards Air Force Base (Work for Others)
- Remote Sensing: Sandia Cooperative Monitoring Center
- Data Analysis: Chemometrics (Org. 1812)
- Packaging: Team Specialty Products (Albuquerque)
- Research: Brigham Young University

Impact:

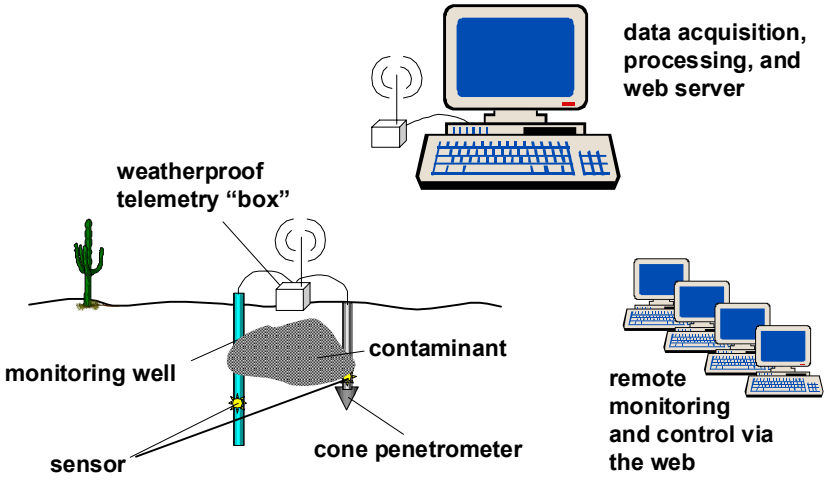


Commercial applications include remote monitoring of gasoline leaks.

- DOE: Addresses environmental remediation and long-term stewardship needs of DOE EM-50 (CMST, Focus Areas)
- Sandia: Provides prototype monitoring system that can be tested at Chemical Waste Landfill. Promotes and integrates activities within Sandia (Microsensors & Microsystems (1700), Data Analysis (1812), Geoscience, ER & Monitoring (6100, 6233)
- Commercial: Provides quantitative characterization and monitoring for gas stations and other underground storage tanks. Provide optimal remediation of commercially contaminated sites.

References:

- Looney, B.B. and R.W. Falta (eds.), 2000, Vadose Zone Science and Technology Solutions, Battelle Press, Columbus, OH, 1540 pp.
- Wilson, LG., L.G. Everett, and S.J. Cullen (eds.), 1995, Handbook of Vadose Zone Characterization & Monitoring, CRC Press, Boca Raton, FL.



Conceptual illustration of automated remote in-situ sensing system.

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