

# New Technologies, New Opportunities for Odour Detection

Dr. John Saffell  
Alphasense Ltd.  
sensors@alphasense.com

# Types of Gases

## Sulphur compounds are the biggest problem

### Organic

sulphur compounds: H<sub>2</sub>S, mercaptans/thiols  
amines  
aldehydes, ketones, alcohols  
methane

### Inorganic

NO<sub>x</sub>, SO<sub>x</sub> (acid gases)  
Ozone, chlorine/ bromine (disinfectants)  
Ammonia (nitrogenation)  
Hydrogen (used as surrogate for clean landfills)

# Current Technologies OK, but could do better

### Organic

Mass Spectrometry (MS) or GC/MS  
Long pathlength FTIR  
Photoionisation Detectors (PID)  
Electronic noses (sensor arrays)

### Inorganic

Electrochemical cells  
NIR laser spectrometry

# New Technologies Not there, yet

### Organic

NIR solid state spectrometry  
Nanomaterial sensor arrays (next generation electronic noses)  
Micro GC/MS (low cost, limited life detectors)  
Ion Mobility Spectroscopy (IMS/ FAIMS)

### Inorganics

Quantum Cascade Laser (QCL) spectrometry  
Cavity Ring Down Spectrometry (CRDS)  
Long wavelength NDIR  
Improved sensitivity electrochemicals

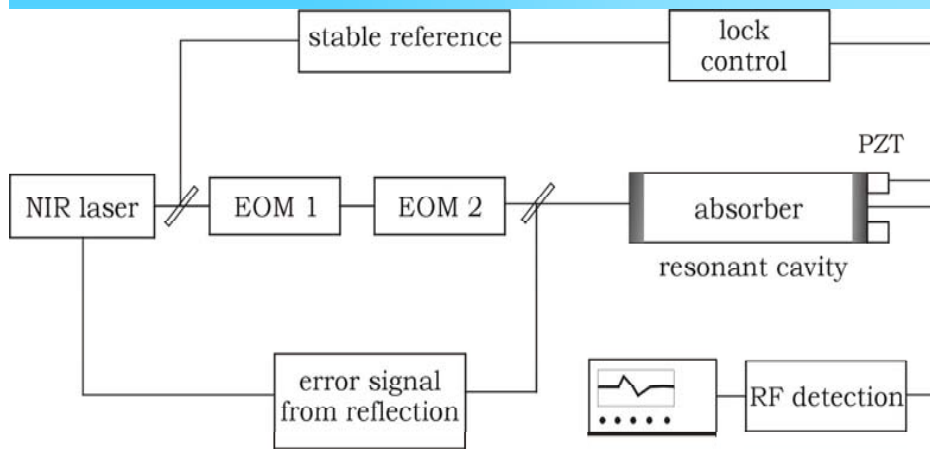
## Quantum Cascade Lasers

- Solid state infrared lasers are now available at wavelengths to 20um

## Resonant Cavity Laser Systems

- Bounce the light through the test cell hundreds, thousands of times to improve resolution
- Cavity Ring Down Spectroscopy (CRDS) is now commercially available for some gases

## Resonant Cavity Diode Laser Absorption

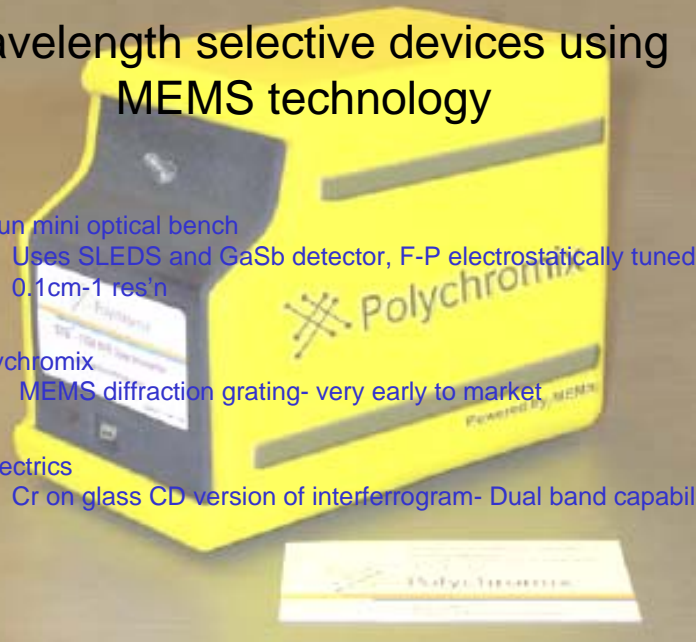


## Near- Infrared spectroscopy has just become cheaper, better

- MEMS devices are replacing expensive optical wavelength selection systems

## Wavelength selective devices using MEMS technology

- Axsun mini optical bench  
Uses SLEDS and GaSb detector, F-P electrostatically tuned  
0.1cm<sup>-1</sup> res'n
- Polychromix  
MEMS diffraction grating- very early to market
- Aspectrics  
Cr on glass CD version of interferogram- Dual band capability



## Electronic noses Sensor arrays

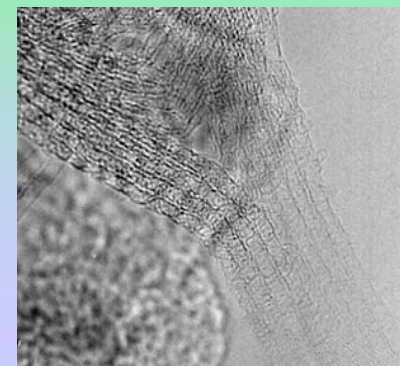
- Based on polymer or semiconductor sensors
- Analysis of the measurements is difficult- keeps the programmers busy.
- Humidity, sensor drift, and array “training” are continuing problems. Hopefully, new sensor materials will rescue this technology.

## Nanomaterials improve sensor performance

- Carbon nanotubes are in development as sensors for ammonia and hydrogen.
- Better organometallic sensing layers are more repeatable, thanks to organic LED (OLED) work for new TV, PC displays.

## Carbon nanotubes

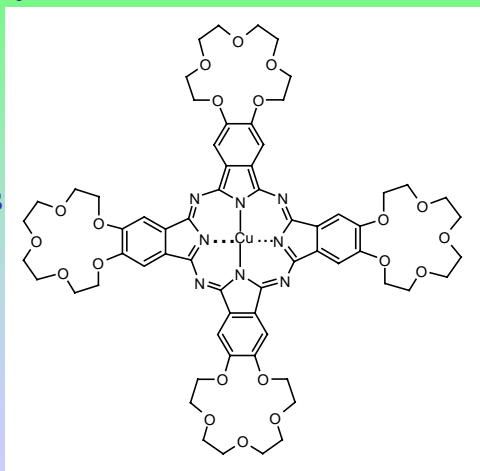
- Chemical resistors, or-
- Electrochemical replacements for graphite



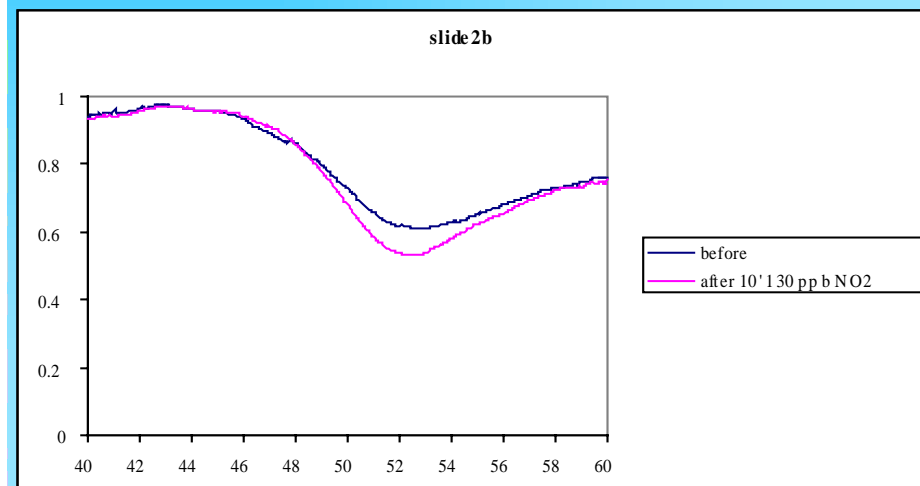
Single Wall CNT

## Sensing layers: organometallic chemistry at its best

- Phthalocyanines
- Crown Ethers
- Dendrimers
- Hydro-, lipophilic chains
- Chiral compounds
- Thiol on gold SAMs



## SPR Response to 130 ppb NO<sub>2</sub>

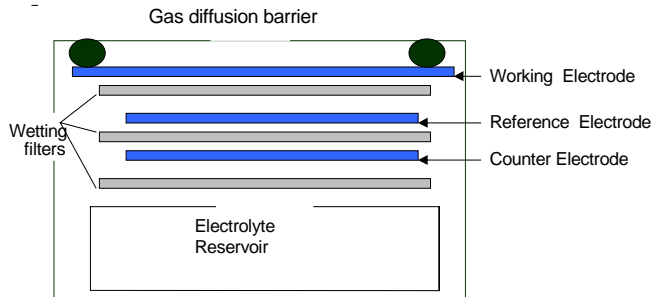


## Amperometric Sensors

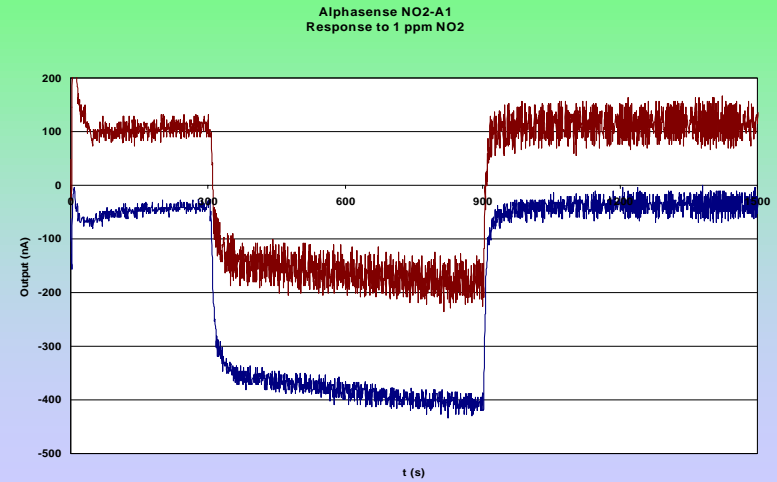
- Standard gas detection technology for H<sub>2</sub>S, SO<sub>x</sub> and NO<sub>x</sub> continues to improve itself.



## 4 Amperometric Electrochemical

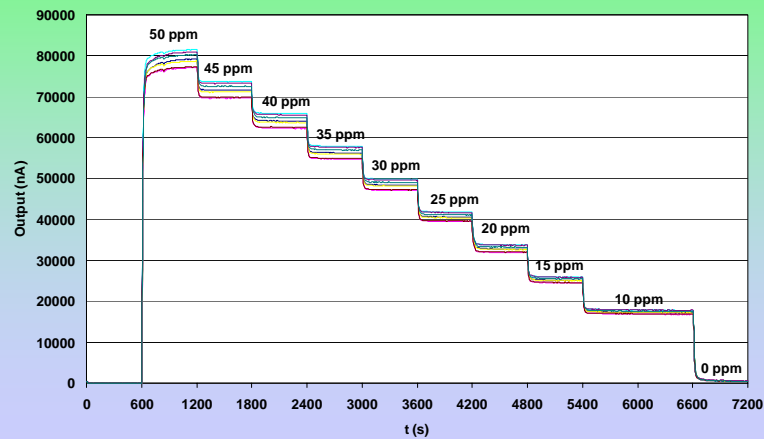


## Electrochemical response to 1ppm NO<sub>2</sub>



## Electrochemicals give good response

Alphasense H2S-BH  
H<sub>2</sub>S Linearity @ 20C



## Gas Cameras

- The ultimate tool to measure odour dispersion in real time.
- But- a technical challenge still under development

# Electronics and Computing come to the rescue

- ASICs and FPGAs give computing power at the sensor.
- Low power wireless ZigBee (IEEE 802.15.4) WiFi and GPS allow instant network systems without cables.
- Silicon MEMS permit low cost sensor arrays.

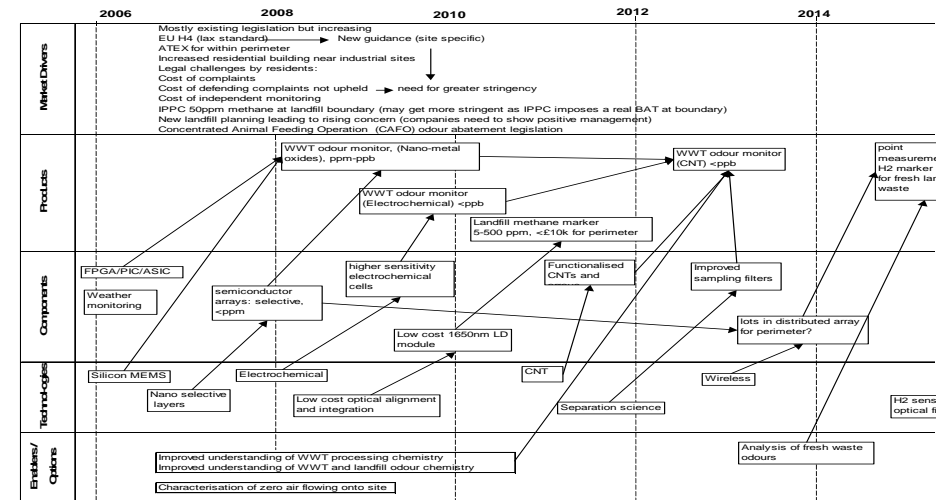
# Conclusions

- VOC analysis using **spectroscopy** will become cheaper.
- H<sub>2</sub>S and other inorganic gases will be cheaply measured at the 10-50ppb level with better **electrochemical sensors**.
- New **sensor materials**- they may be the hope for ammonia and mercaptans, but- still too early.
- Dioxins, PCBs will be analysed at the sub-ppb level inexpensively with the next step after PIDs: **Differential Mobility Spectroscopy**.
- **Research** is needed to determine how the hydrocarbons and hydrogen are useful surrogates for landfill monitoring.

# What does the future offer us? When?

- These technologies are in development.
- But we are not there yet- products must be developed and supporting research is needed to ensure correct interpretation.

MNT Gas Sensors Roadmap- Odour Monitoring



# MNT Gas Sensor Forum

Visit our website

[www.gas-sensor-roadmap.com](http://www.gas-sensor-roadmap.com)