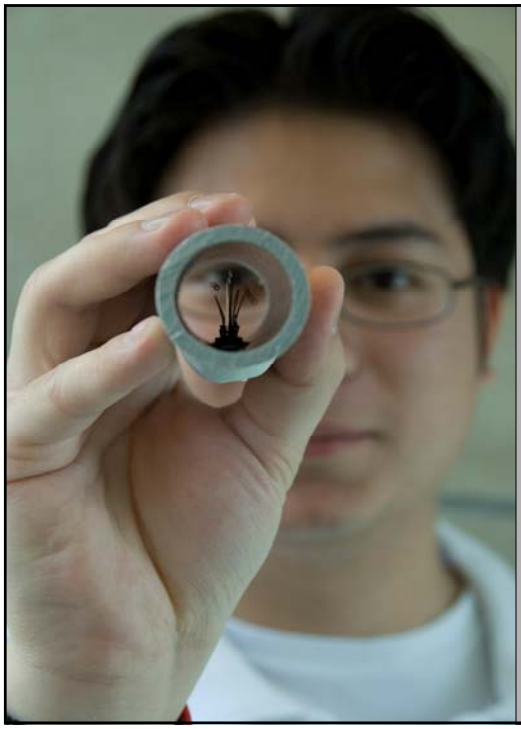

"DETECTION"

Persistent surveillance is made possible by small, inexpensive metal-oxide gas sensors.

A Persistent Surveillance Technique for the Detection of Explosive Precursors

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*A simple, inexpensive gas detection system using metal oxide catalysts is being developed to unambiguously detect minute concentrations of specific gas molecules****……micro-differential thermal analysis of explosives/explosive precursors***

PAYOFF for DHS

- early detection of explosive precursors in enclosed areas with nearly immediate detection of targeted gas molecules……

  w/o interference effects from background gases

DETAILS

- apply combinatorial material synthesis to create new catalyst libraries.
- using the libraries to identify optimal catalyst compounds for target molecules
- produce sensors to demonstrate technology in field trials

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Acknowledgements

SensorTech, Inc., Savanna, GA

DARPA

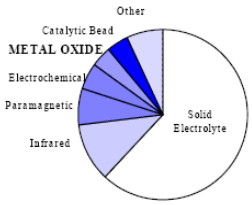
US Army Research Office

Department of Homeland Security
Center of Excellence in Explosives Detection

Ideal Characteristics of Gas Detectors

- *sensitive -low detection limits*
- *selective - unambiguous identification of target molecules*
- *stable and repetitive response*
- *inexpensive*
- *small footprint - portable and compact,*
- *real time continuous monitoring*
- *deployment in large scale unattended networks*

Tradeoffs……..



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Metal-oxide gas detectors

Two functions in metal-oxide gas sensors:

Receptor function:
chemistry of surface e.g. adsorption, decomposition, other reactions which are a strong function of temperature…… (thermally activated processes)

Transducer function:
transduces the chemical response into an electrical signal

*The metal oxide in most gas sensors serves both functions but these functions are "separate" in our sensors …… based on micro-differential thermal analysis**

thus our sensors are not limited by the temperature (low vs high temperature) or the electrical properties of the metal oxides including hysteresis effects when returning to the original state,

** very low thermal masses associated w/thin films*

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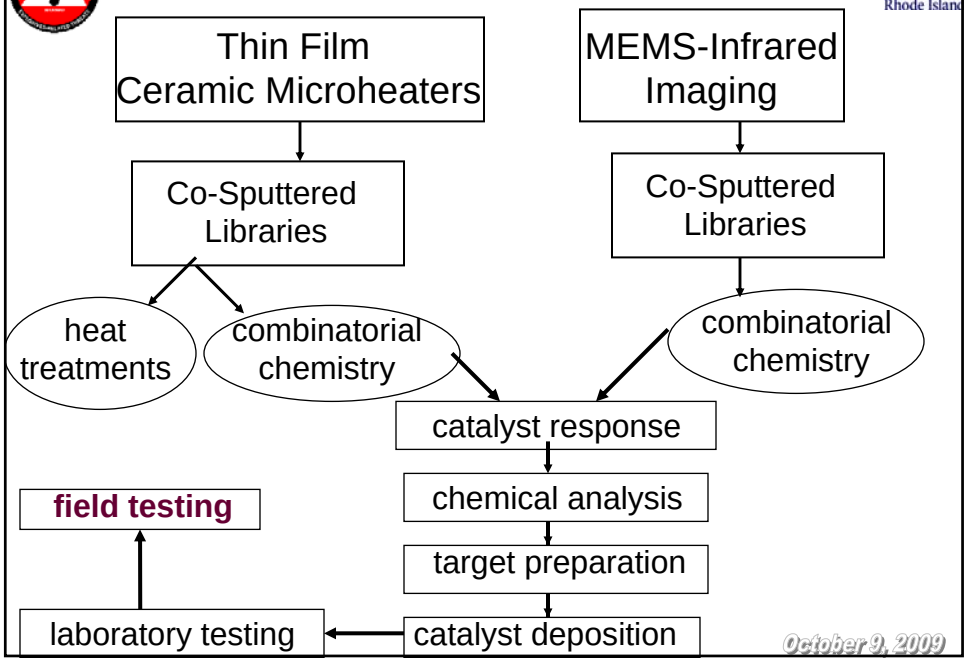
Gas Sensor platforms



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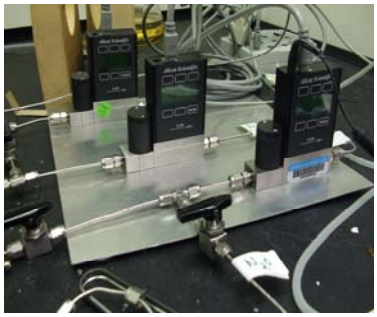
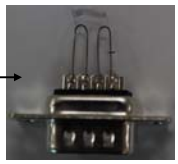
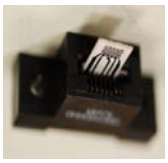
Test bed for determination of catalyst response

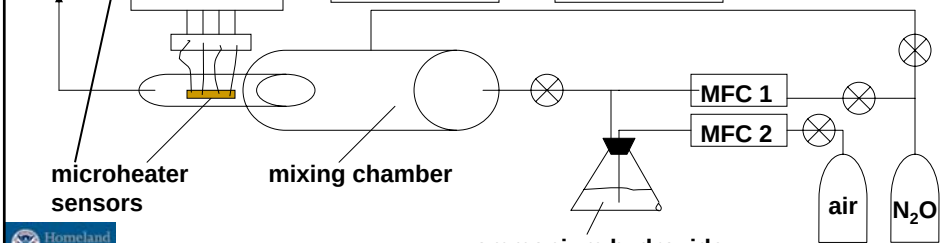
Catalysts investigated for NH_3 detection:

V_2O_5, $AgCoO_2$, CuO, FeO, Fe_2O_3,CuO/FeO TiW, TiO_2, WO_3, ZnO, Pd/ZnO, Pd/$AgCoO_2$, Pd/W

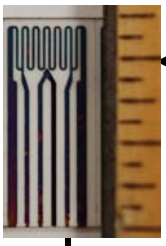


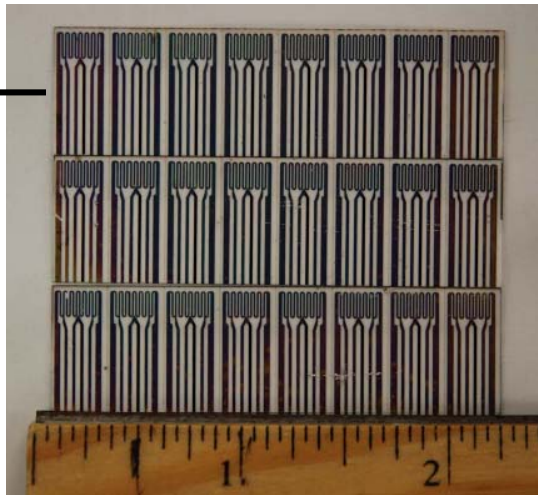


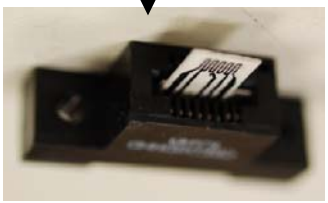




Solid State Microheaters Formed on Alumina Supports used for Rapid Screening of Catalysts







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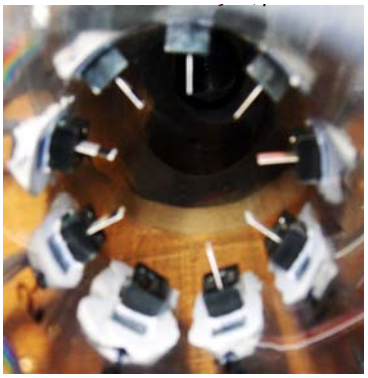
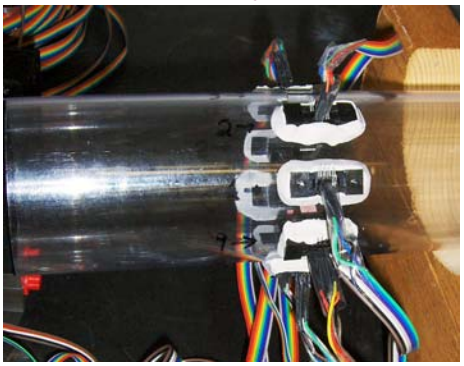
Test Bed for Rapid Screening of Catalysts Ceramic (Alumina) Solid State Microheaters





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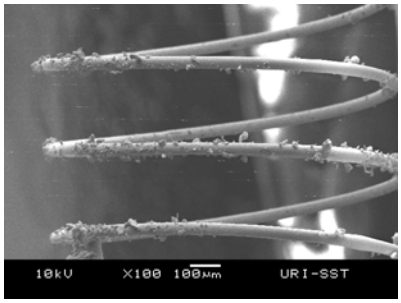
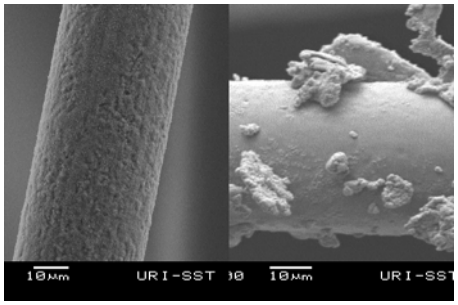
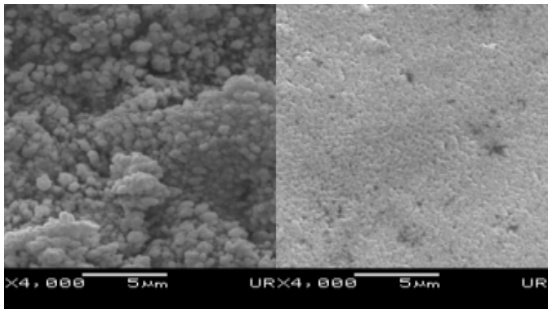
Surface Area of Catalyst Support was Increased Using Single Wall Carbon Nanotubes (SWNT's)







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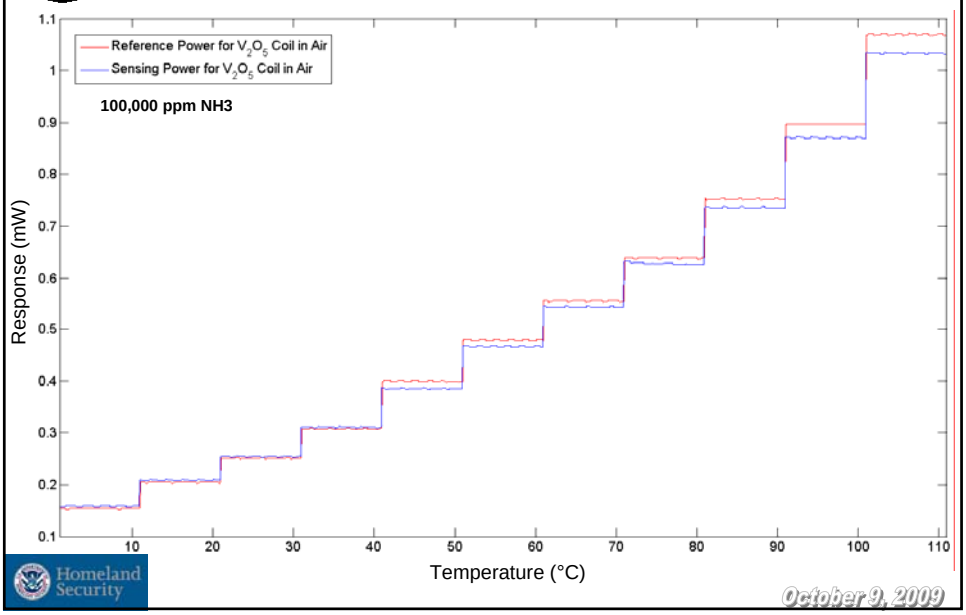
Power Difference/Response with V_2O_5 Catalyst as a Function of Temperature



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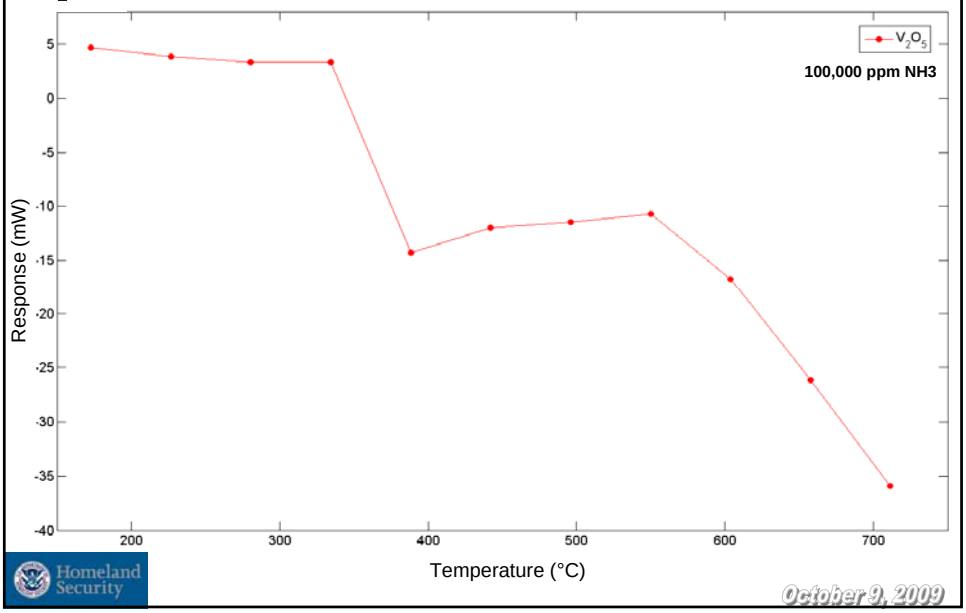
Sensor Response with V_2O_5 Catalyst as a Function of Temperature



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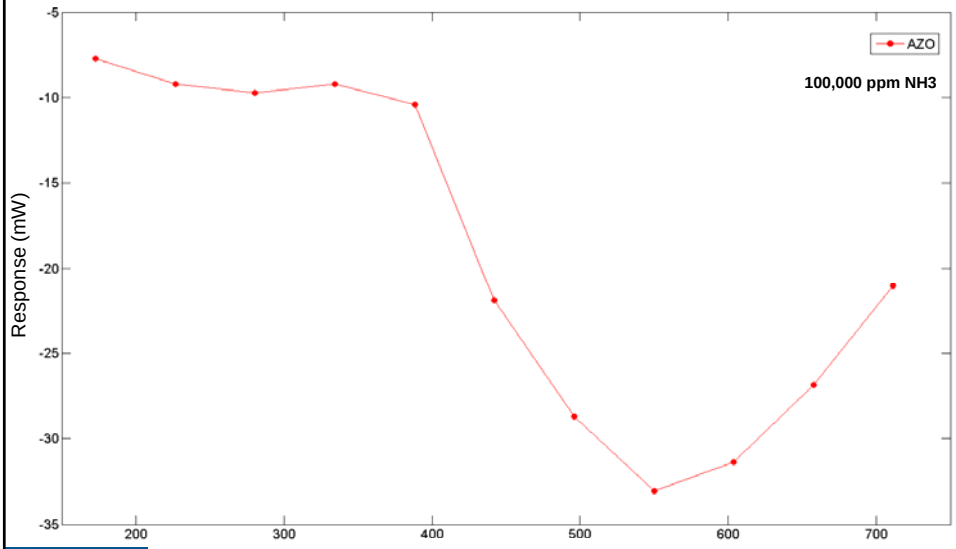
Sensor Response with ZnO Catalyst as a Function of Temperature



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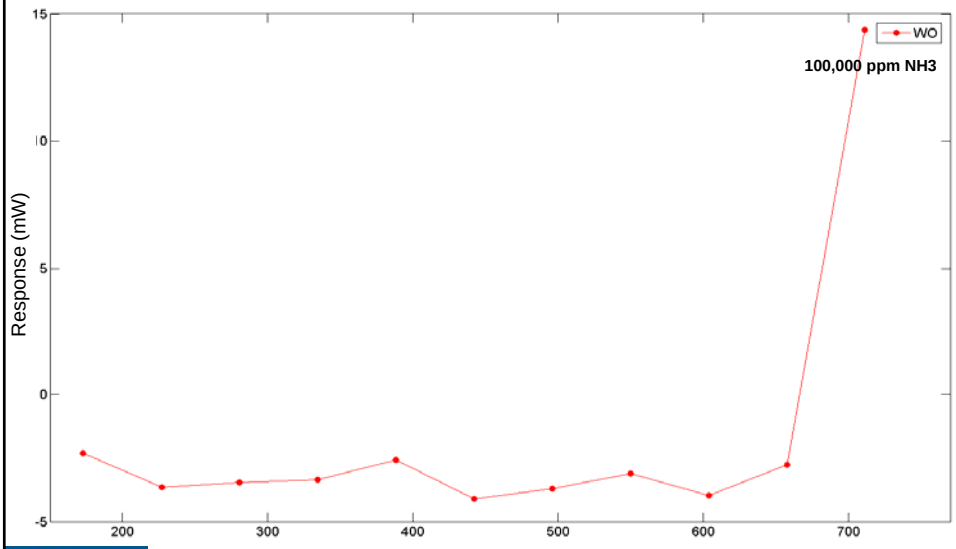
Sensor Response with WO Catalyst as a Function of Temperature



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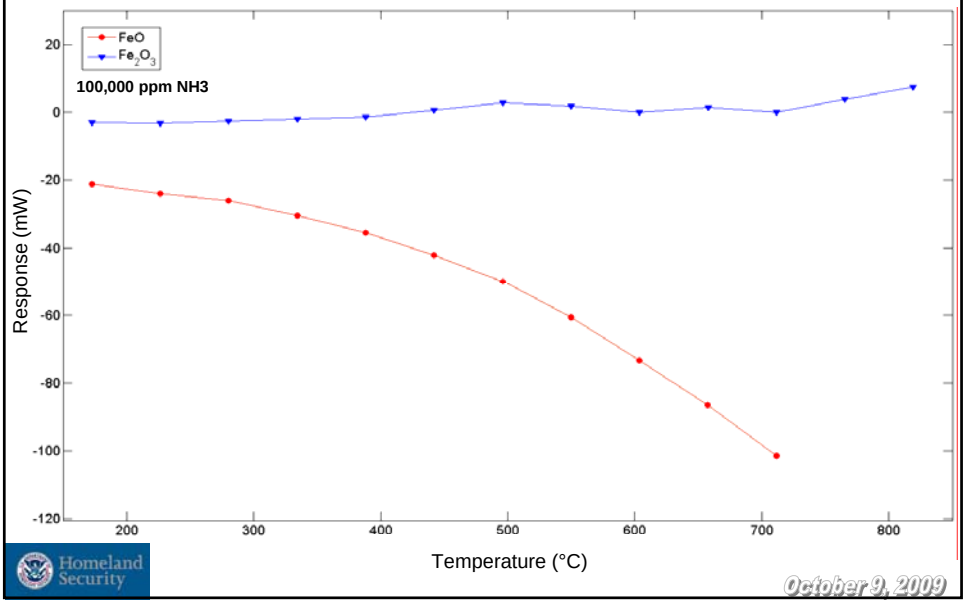
Sensor Response of FeO and Fe_2O_3 Catalyst as a Function of Temperature



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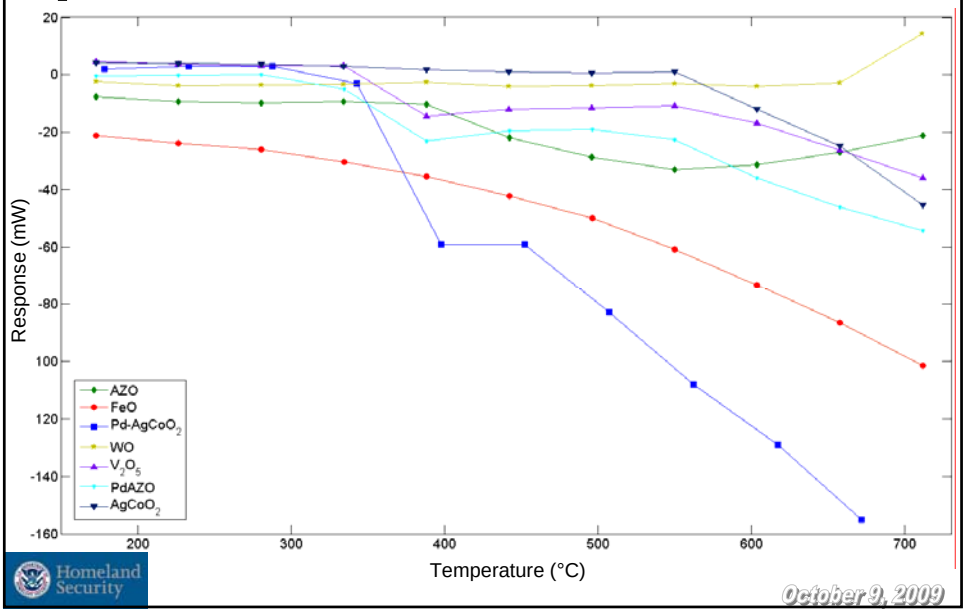
Sensor Response of Various Catalysts as a Function of Temperature



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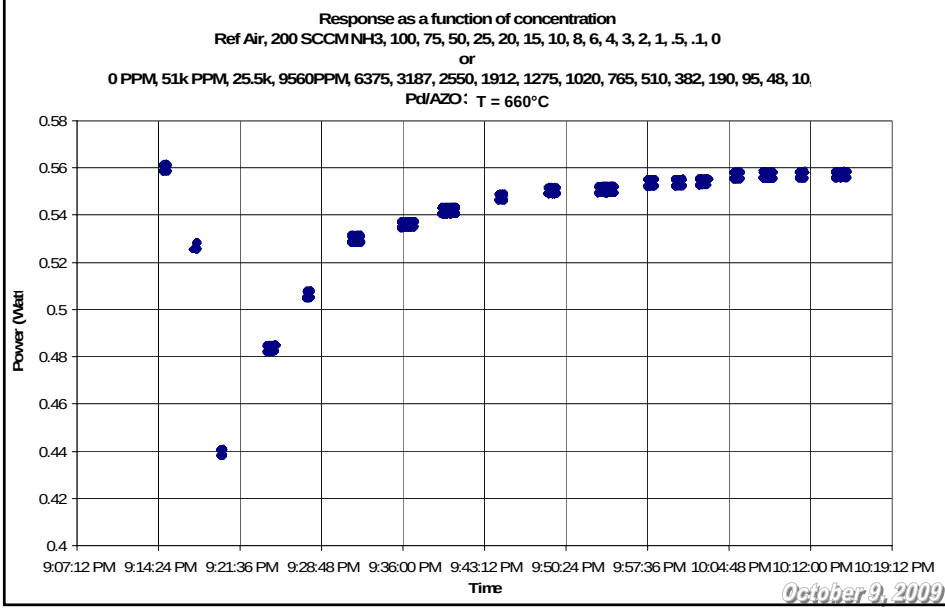
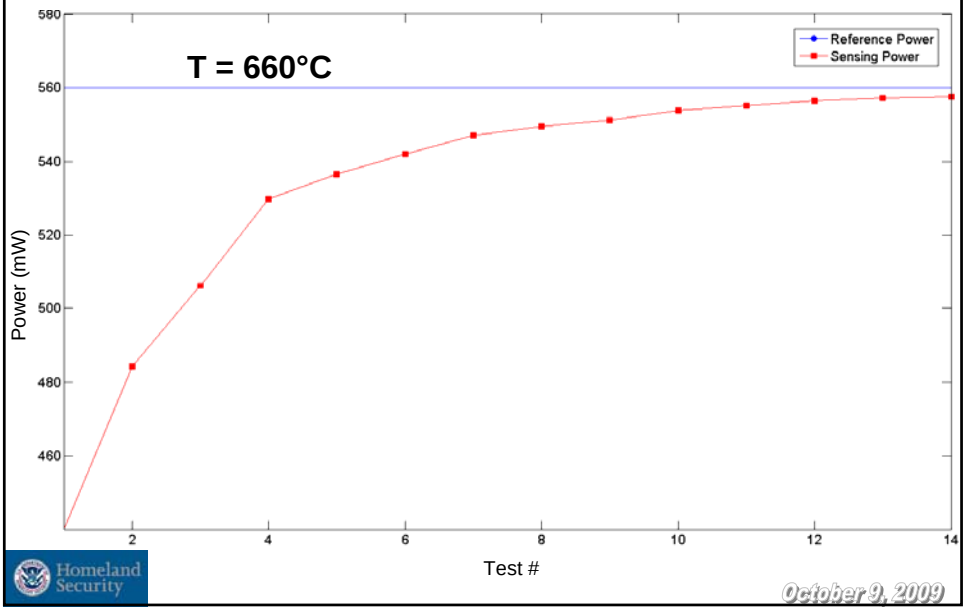
Effect of Target Gas Concentration on Sensor Response

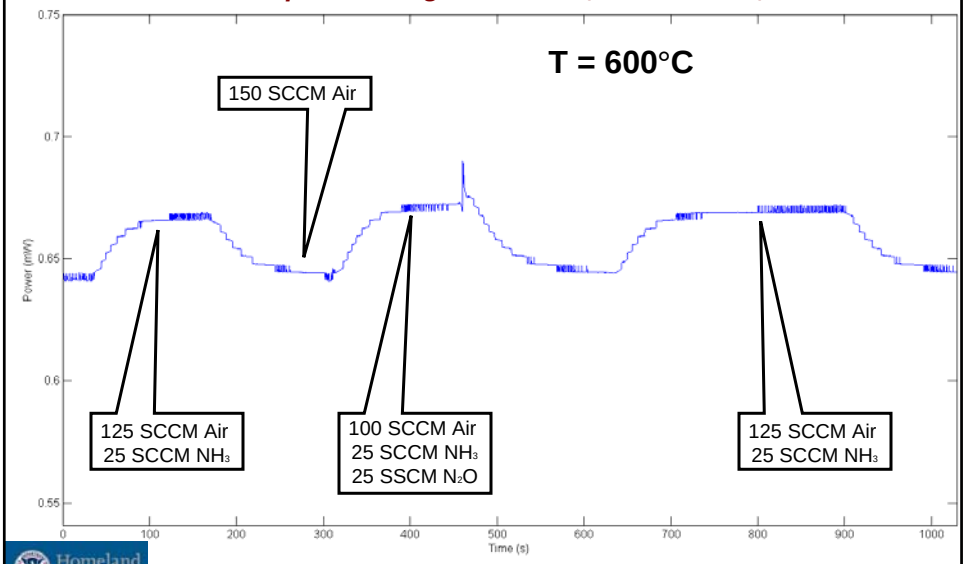


Pd-AZO Coil response with 25000, 9560, 6375, 3187, 2550, 1912, 1275, 1020, 765, 510, 382, 190, 95, 48, and 10 PPM NH_3



Effect of Interference/Background Gas

Sensor Response of $AgCoO_2$ in NH_3, NH_3 and N_2O, and NH_3



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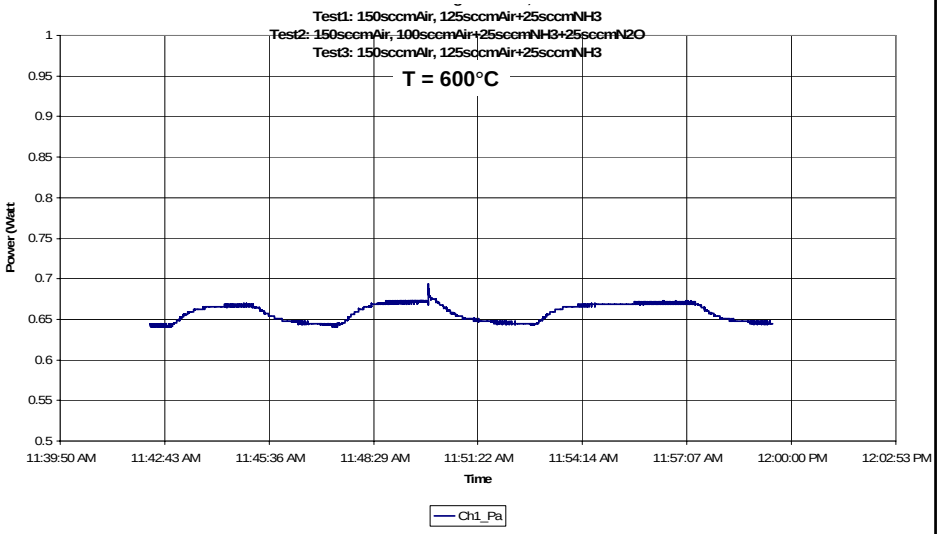
Effect of Interference/Background Gas



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Effect of Interference/Background Gas

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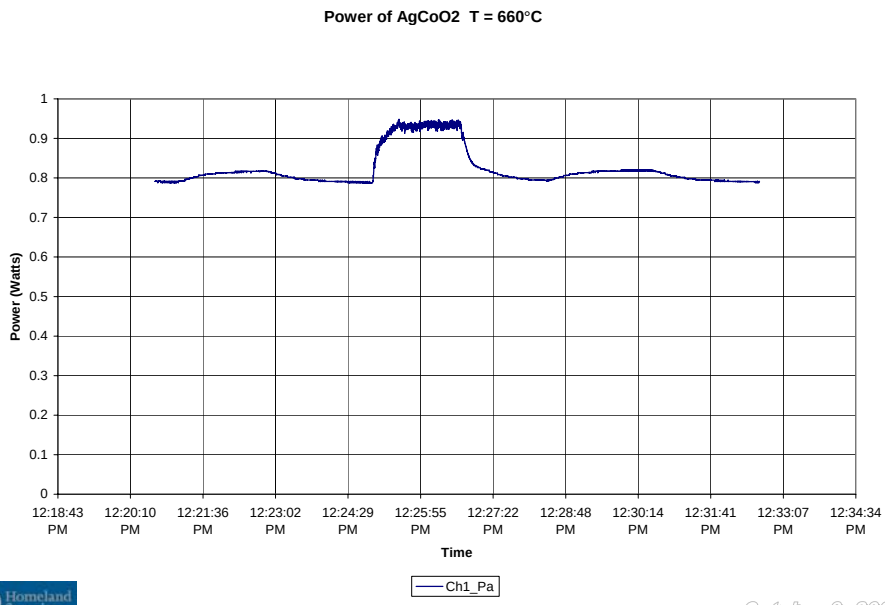

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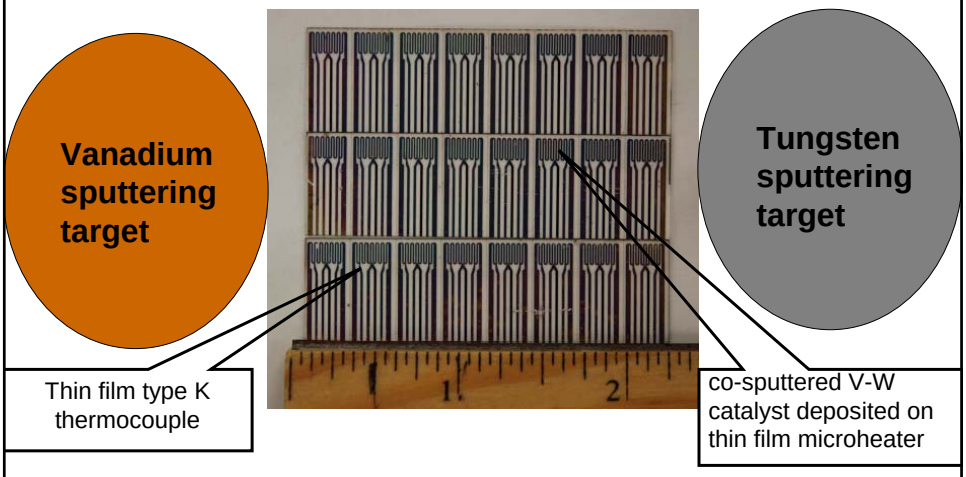
Co-sputtering of metal-oxide combinatorial libraries



catalyst combinations: V_2O_5-FeO, AgCoO-Pd, ZnO-Pd, CuO-FeO

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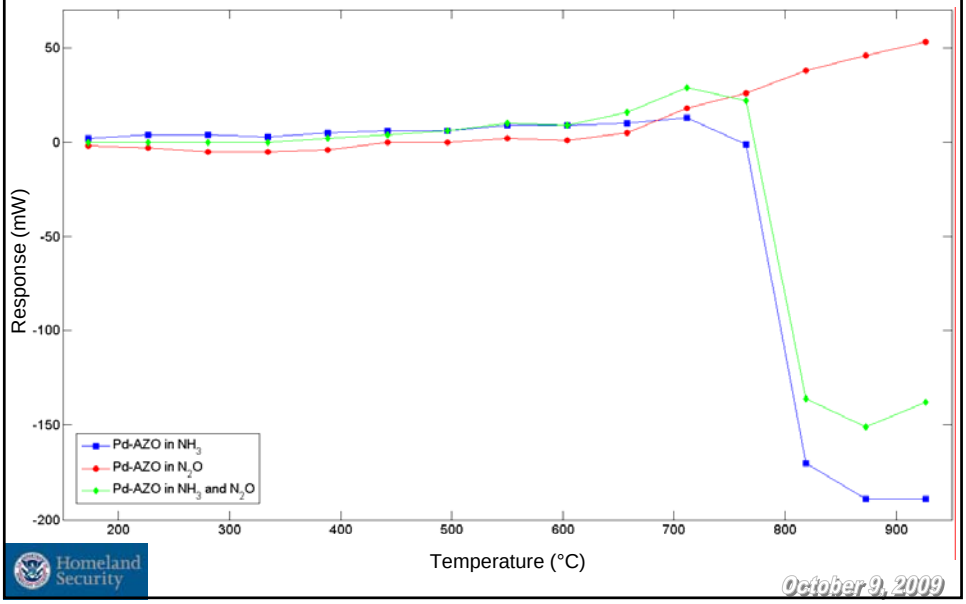
Response of Pd-AZO as a function of temperature in NH_3, N_2O and NH_3, and N_2O



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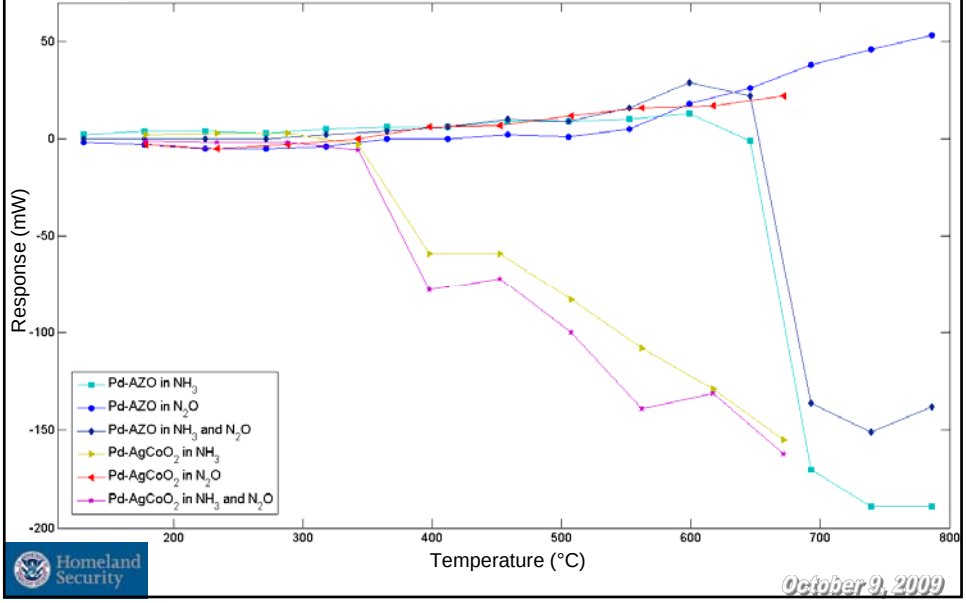
Response of Pd-AZO and $PdAgCoO_2$ as a function of temperature in NH_3, N_2O and NH_3, and N_2O



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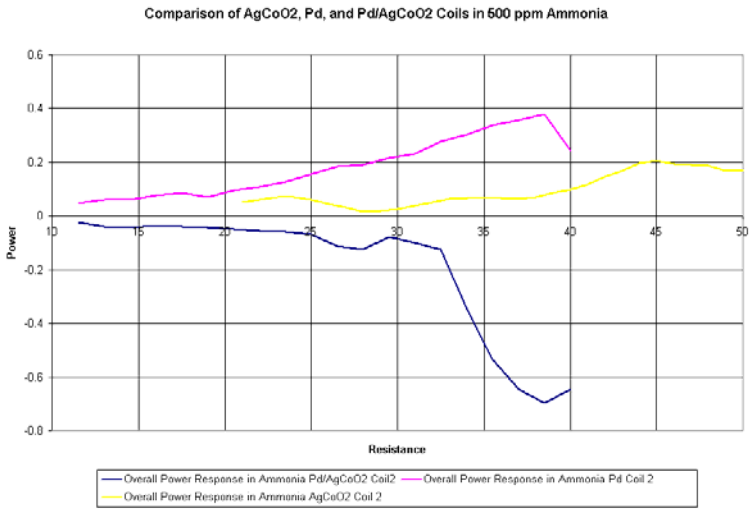
Response of Pd-AZO as a function of temperature in NH_3, N_2O and NH_3, and N_2O



Summary

- Laboratory experiments were performed using two different sensor platforms to establish the most responsive catalysts when ammonia was used as the target gas.
- The concentration dependence of ammonia on sensor selectivity and response was established
- The effect of interference / background gases such as NO_2 on NH_3 response was investigated to determine thresholds.
- $Pd/AgCoO_2$ and Pd/ZnO combinations were the most responsive catalysts developed to date using these sensor platforms.

Long Range Impact of Research

The design and fabrication of arrays of microheater sensors each optimized for a particular target gas, will be integrated onto a chip such that an unknown gas sample could be analyzed for a large number of potential threats in real time.