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# **THERMAL SIMULATION AND PACKAGE INVESTIGATION OF WIRELESS GAS SENSORS MICROSYSTEMS**



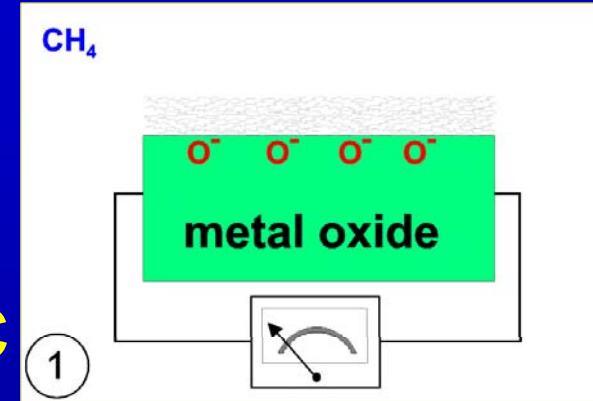
# Outline

- How gas sensors work
- Standard package
- Comsol simulations
- Proposed package
- Results summary
- Conclusions

# How Gas Sensors work



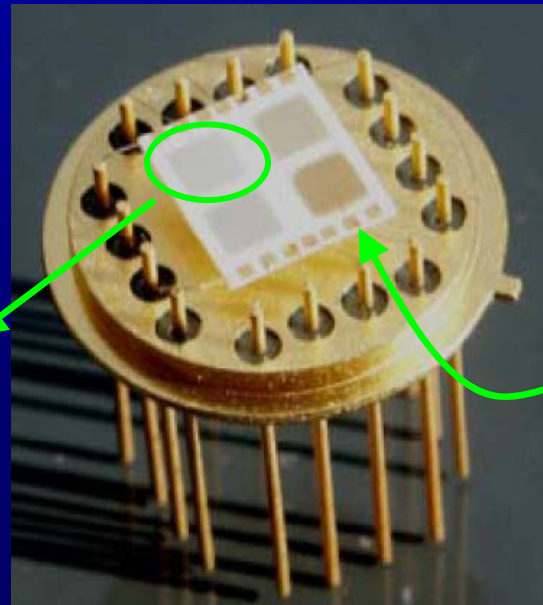
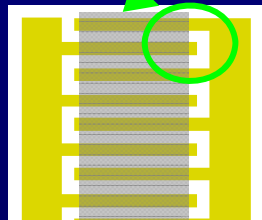
target gases **MUST**  
touch the surface



Chemical reaction needs more than  $150^\circ C$

Top layer:

- electrodes + oxide
- Pt wire thermometer



Bottom layer:

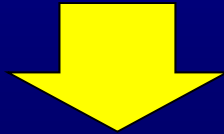
- Pt heater



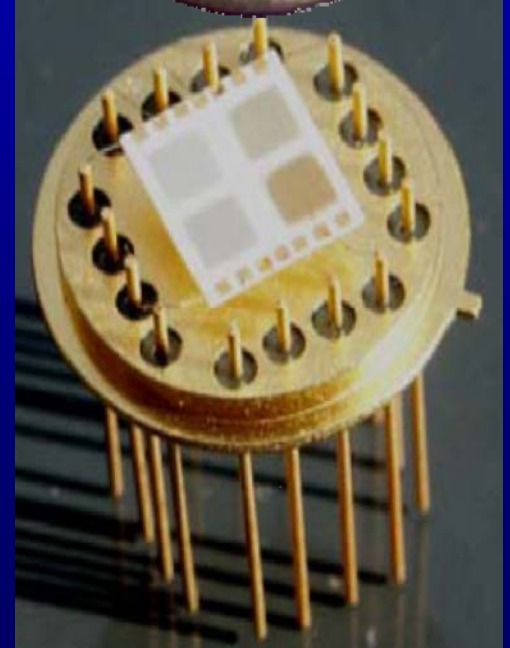
# Standard Package

- *Standard TO8 package with hole and grid on top*
- *Sensor is suspended using bonding wires to provide thermal insulation*

Hot sensor inside



convective flow

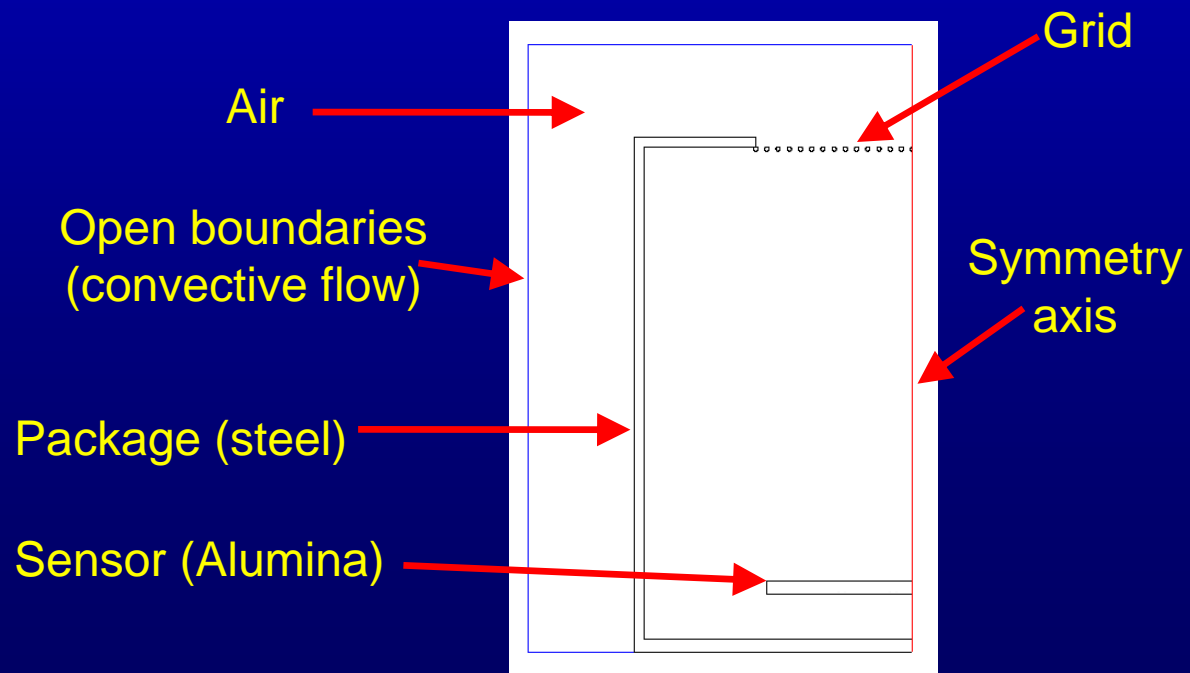
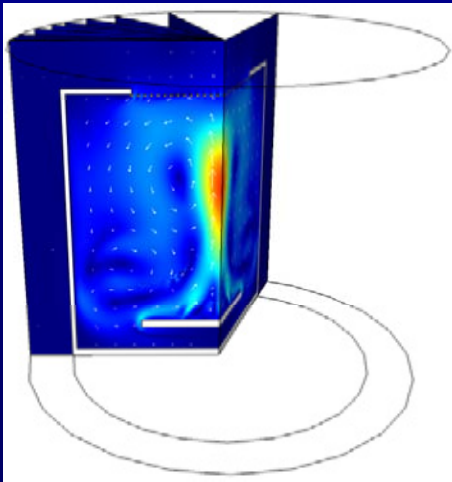


# Comsol simulation (1)

Predefined coupling with

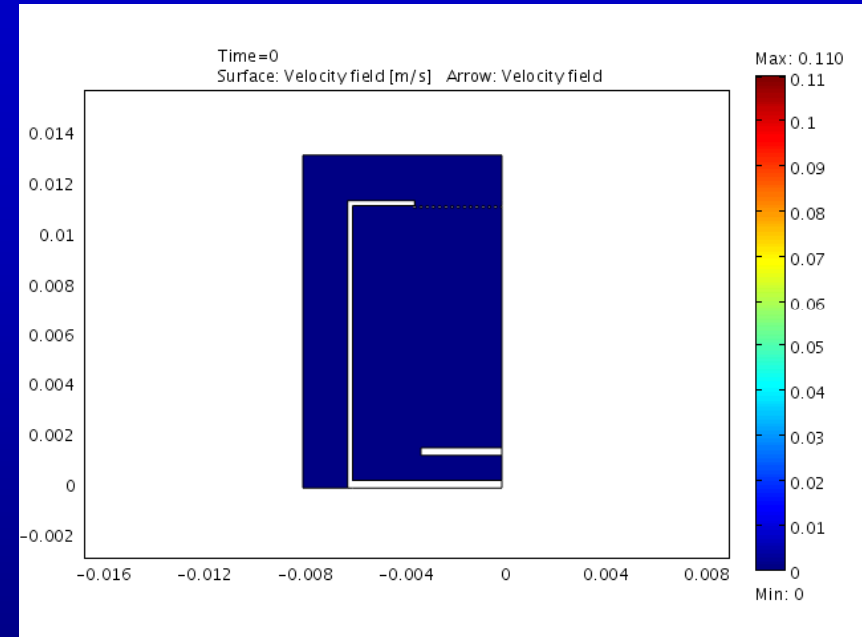
- Incompressible Navier Stokes (ns)
- Convection and Conduction (cc)

2D model with axial symmetry



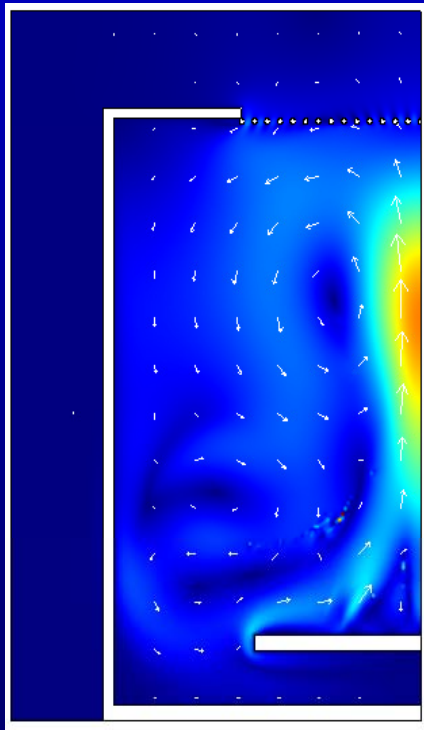
# Comsol simulation (2)

- Time domain simulations
- Heater, thermometer and external temperature regulator simulated using mathematical expressions
- Mesh too fine: it was impossible to simulate
- Mesh too coarse: simulation was inaccurate

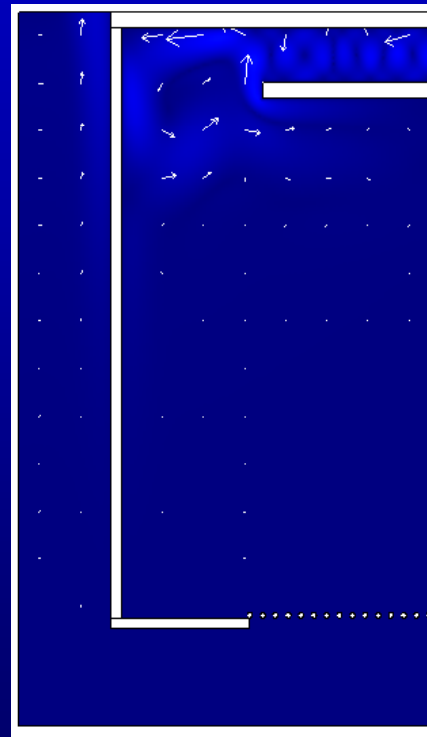


# Results with standard package

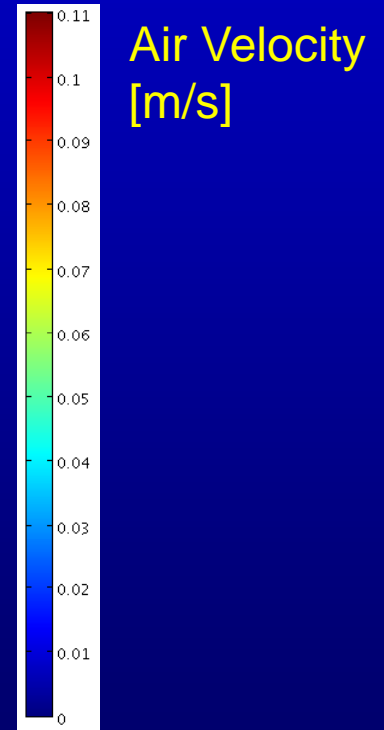
- Poor air exchange



Sensor "face up"

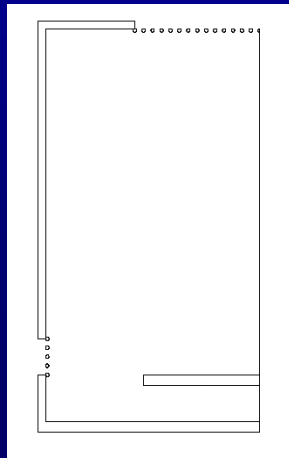


Sensor "face down"



# Proposed package

- Similar to the standard package but with windows on the vertical wall, near to the sensor



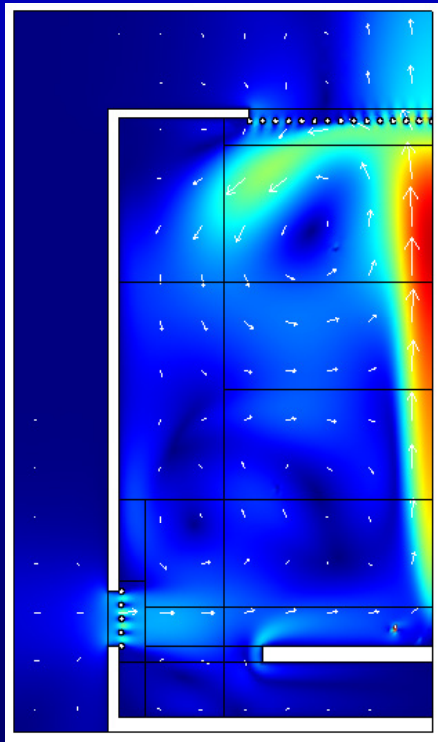
2D model using axial symmetry as the previous one



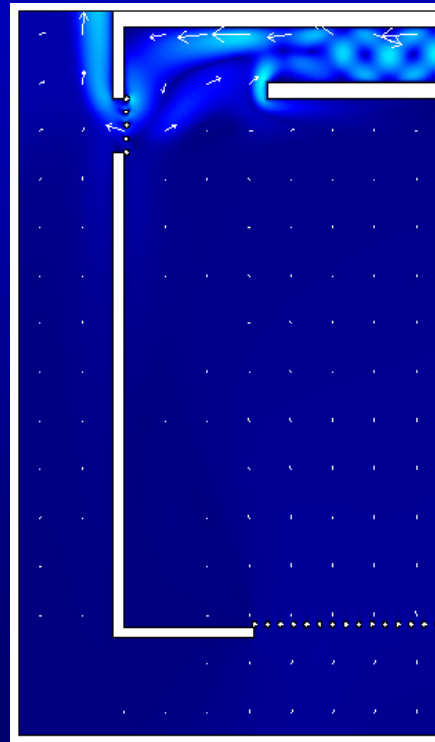


# Proposed package results

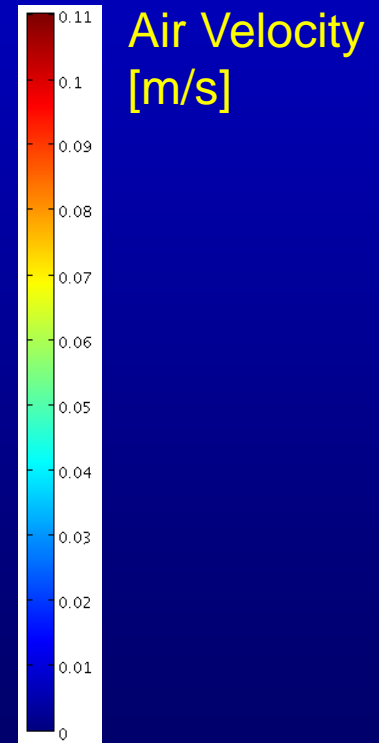
- Improved air exchange



Sensor "face up"



Sensor "face down"



# Results summary

	Standard package face up	Standard package face down	Modified package face up	Modified package face down
Average inlet velocity [m/s]	$4 \cdot 10^{-2}$	$4 \cdot 10^{-5}$	$5 \cdot 10^{-2}$	$5 \cdot 10^{-3}$
Average outlet velocity [m/s]	$4 \cdot 10^{-2}$	$4 \cdot 10^{-5}$	$6 \cdot 10^{-2}$	$2 \cdot 10^{-2}$
Average exchange flow [m <sup>3</sup> /s]	$6 \cdot 10^{-7}$	$6 \cdot 10^{-10}$	$1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$

# Conclusion

- Comsol has been used to simulate convective flows in sensor packages
- Simulation results have been used to design a new package to improve the sensor efficiency
- Further improvement can be done finding the best position of the new package aperture