HEGO SENSORS

Motivation

Automotive Heated Exhaust Gas Oxygen (HEGO) sensors are susceptible to chemical reduction (i.e., blackening). This condition is reversible, but the integrity of the sensor can be compromised.

Objective

Chemically reduce and re-oxidize various HEGO sensors and establish qualitative and quantitative relationships regarding sensors integrity based on the electrical behavior of the sensor.

Methodology

Chemically reduce and re-oxidize several HEGO sensors

Measure the electrical performance of the re-oxidized HEGO sensors

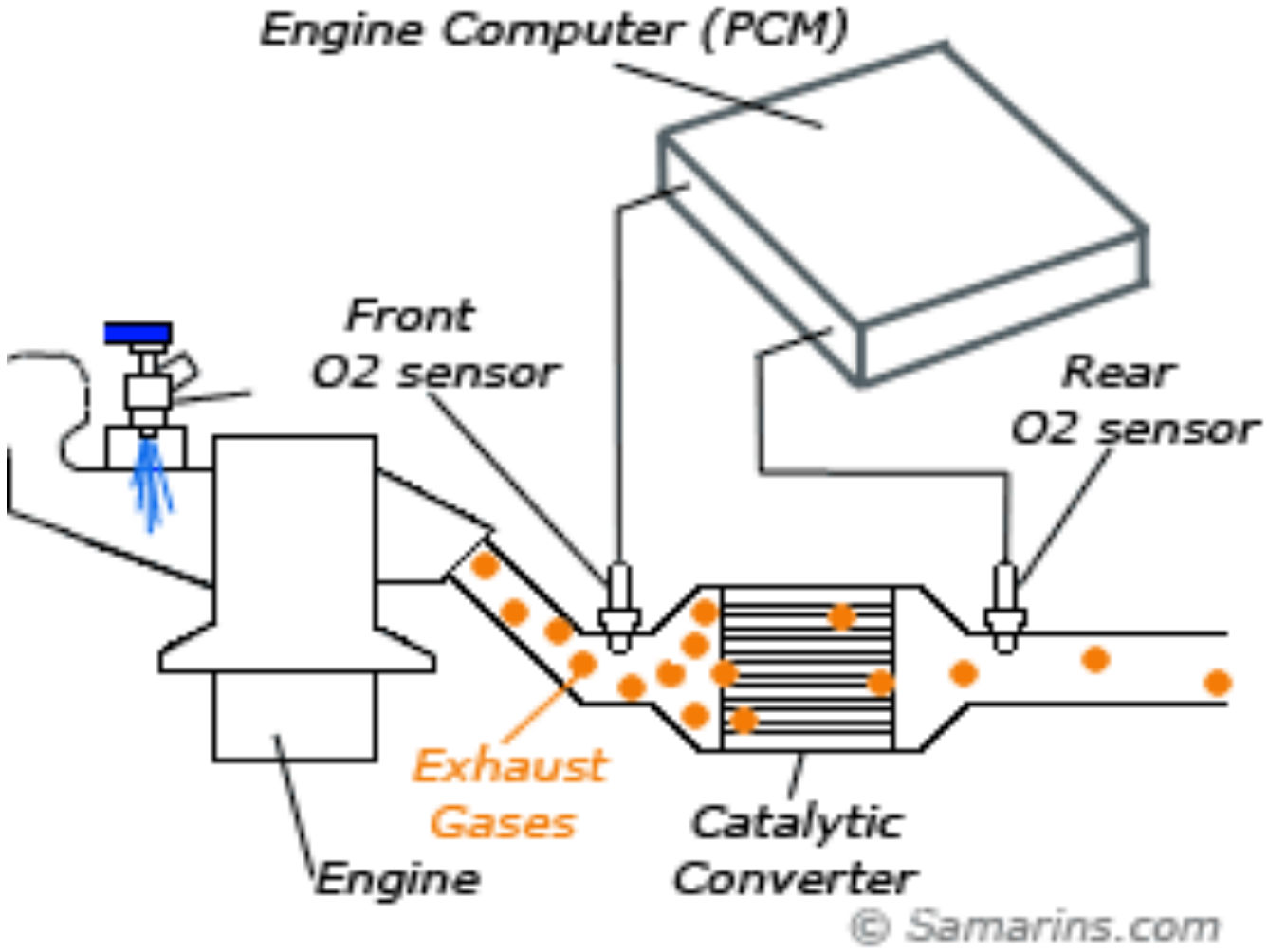
Collect optical images of the sensors before and after reduction and oxidation: as well as after electrical testing

Obtain X-ray Diffraction data describing the crystal structure of the sensors

Goal

Understand the behavior of HEGO sensors following chemical reduction

Background


Engine Computer (PCM)
Front
O2 sensor
Rear
O2 sensor
Exhaust
Gases
Catalytic
Converter
Engine
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DR. E. MURRAY

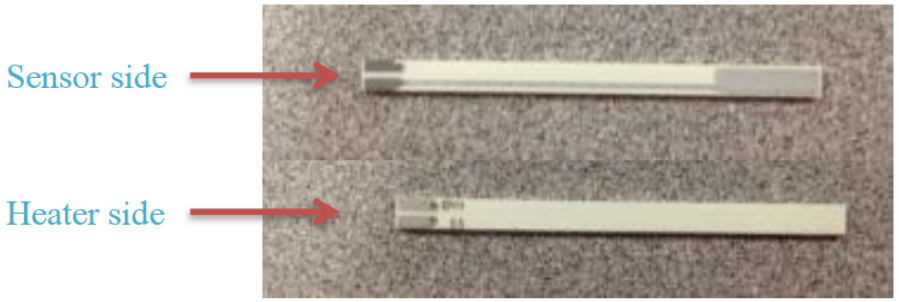
MR. ROGERS ARRIVES

WHAT DR. MURRAY WAS REALLY THINKING

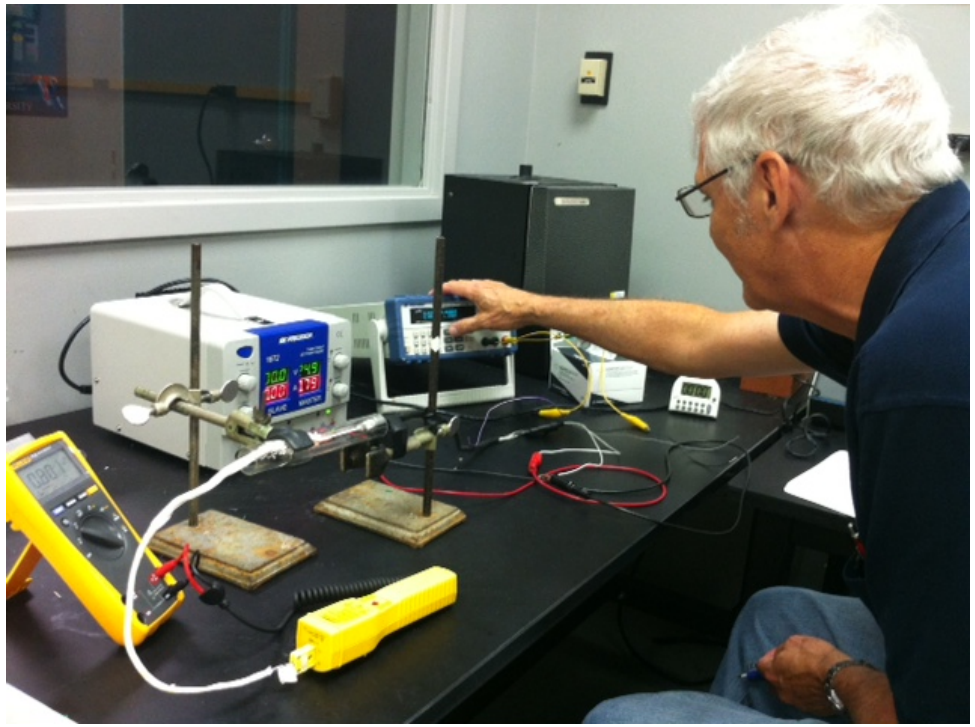
Methodology

- 4-5 HEGO sensors were electrically tested.
- A power supply was connected to the heater side of the HEGO sensor.
  - The applied voltage and corresponding temperature was determined.
  - The desired sensor operating temperature (800°C) was determined by this method.
- A 2nd power supply was connected to the sensor electrodes.
  - Various voltages were applied and the resulting current was measured.
- A thermocouple was used to measure the sensor temperature.

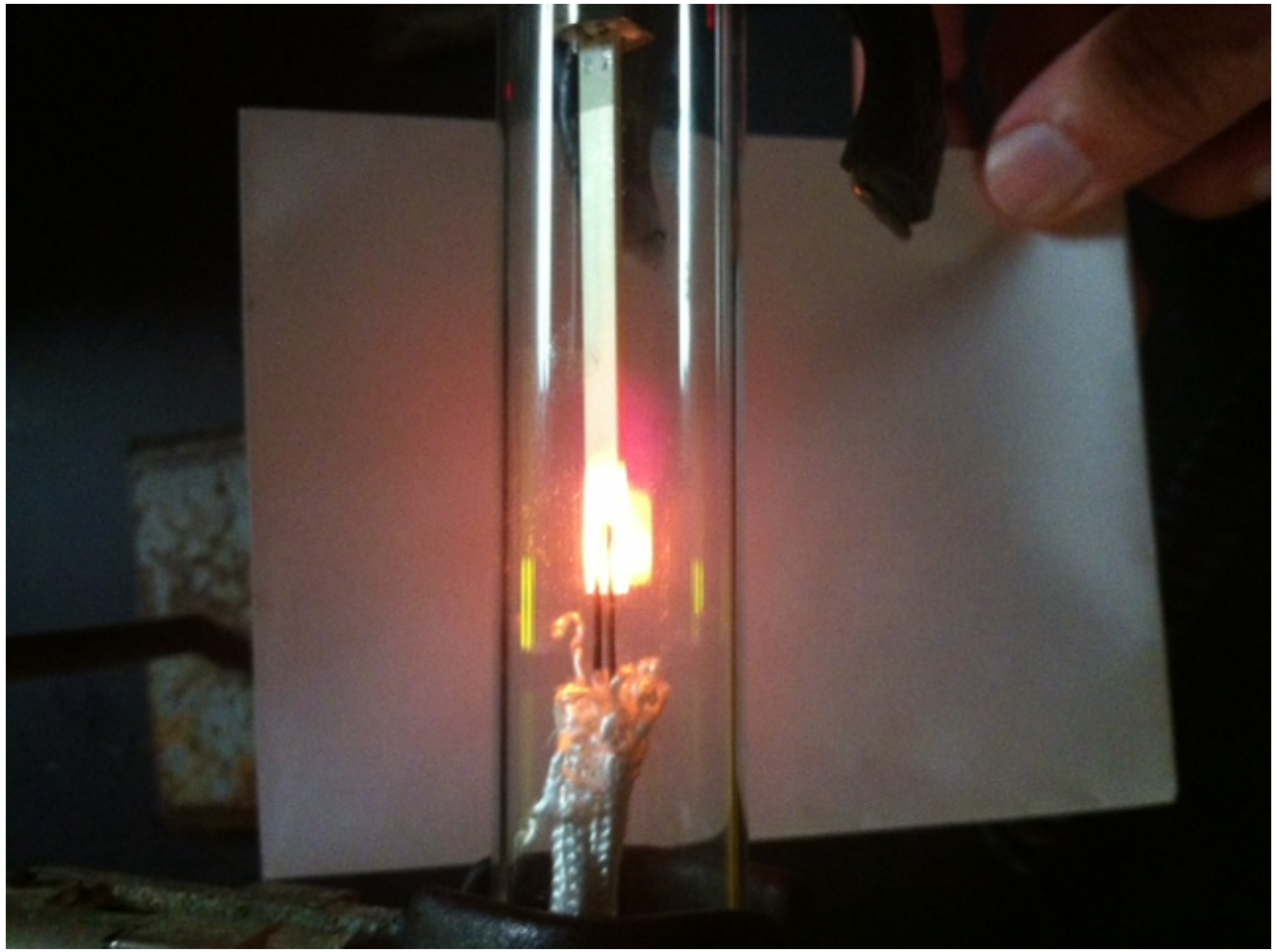
Sensor & Setup

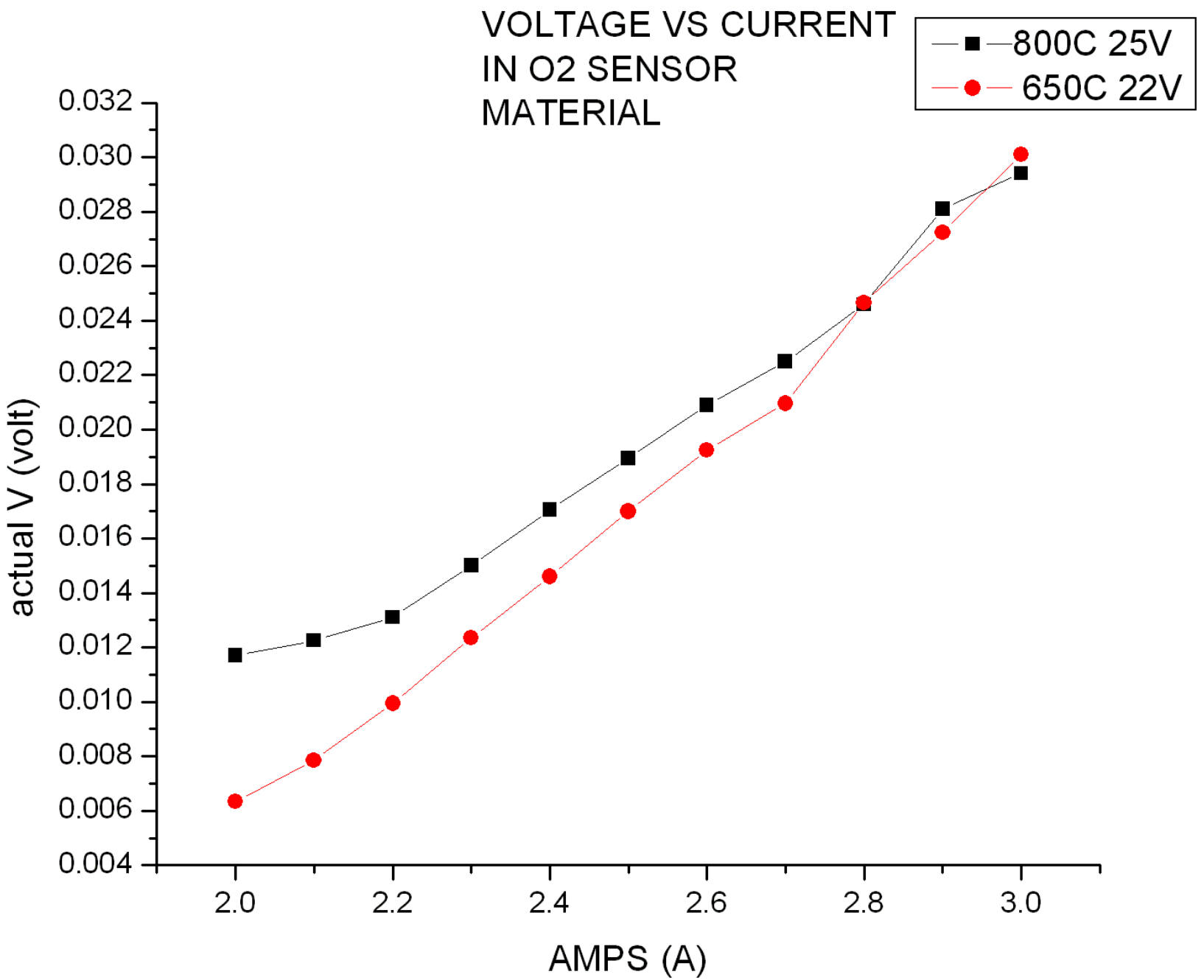


HEGO Sensor image from Arwa Alshowaier Practicum Report 2012.



Sensor Operation at 800°C




VOLTAGE VS CURRENT
IN O2 SENSOR
MATERIAL
800C 25V
650C 22V
actual V (volt)
0.032
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
2.0
2.2
2.4
2.6
2.8
3.0
AMPS (A)

Experimental Issues

- Issues with the thermocouple
- Several HEGO sensors were tested but did not observe chemical reduction.
  - It's possible that the voltages tested were below the threshold for reduction.
  - Sample holder was bad and had to be replaced.
  - Researcher was slow to get a good grasp on the procedure which resulted in three burned out samples and a cracked test tube.

Summary

- The HEGO sensors were highly stable (meaning the current and voltage data did not change much).
- The applied voltages did not result in chemical reduction of the HEGO sensors as expected.
- The HEGO sensor current output became temperature independent after approximately 2.8V.
- Future work can consider exploring higher voltages as well as using additional analysis techniques, such as X-ray diffraction.

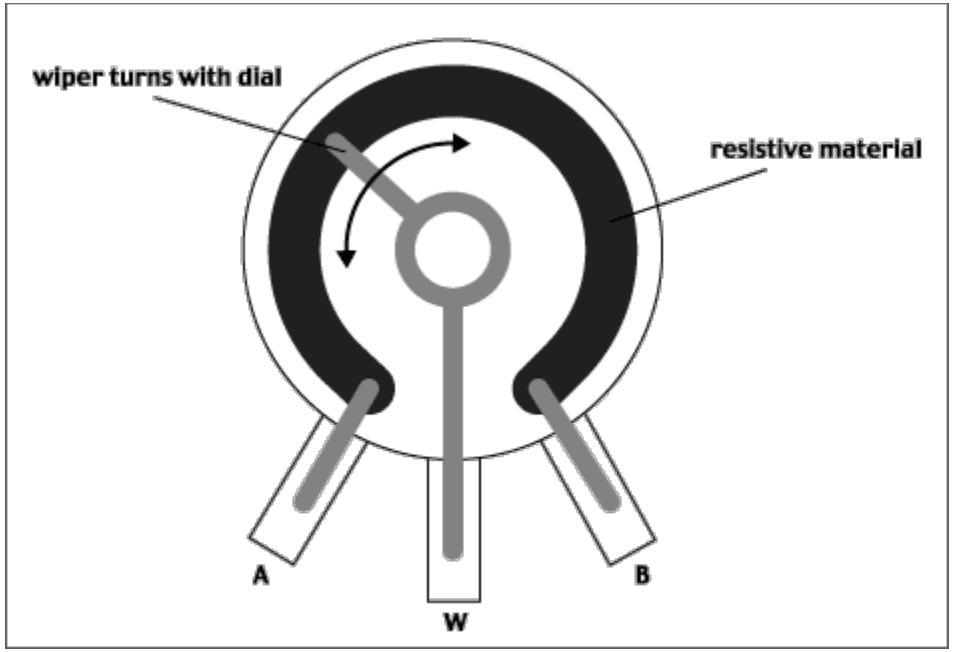
SCIENTIFIC METHOD

- Question?
- Hypothesis
- Variables
- Heater Temperature?
- Now what?

HANDS ON (But Not Your Classmates)

- Resistance Lab
- Fan motors-one fan controller, one meter reader and one recorder.
- Record fan resistance (ohms) at high speed then low speed. Using the values found find medium setting and record ohms.
- Graph data.

Rheostat Switch



FINAL QUESTION

- WHAT IS THE RELATIONSHIP BEETWEEN RESISTANCE AND CURRENT(AMPS)?

- A. DIRECT POSITIVE
- B. DIRECT NEGATIVE
- C. INVERSE
- D. DON’T KNOW, DON’T CARE

CONCLUSION

- Students able to see, hear, smell, and touch electrical resistance and plot an inverse relationship (As current goes up, resistance goes down).