

CEG499/699-13: INTELLIGENT SENSOR SYSTEMS
LABORATORY V: TEMPERATURE MODULATION

The purpose of this laboratory is to improve the discrimination capabilities of your sensor array by means of temperature modulation. Instead of maintaining a constant heater voltage (operating temperature) during exposure to the analytes, you will change or modulate it.

The reason for modulating the heater voltage is that the selectivity and sensitivity of metal oxide gas sensors can be modified by changing the operating temperature, as shown in **Figure 1**. By exciting the heater with a changing voltage, you can treat the sensor response at each temperature as a “pseudo-sensor” with (somewhat) unique sensitivity/selectivity characteristics.

GOOD NEWS: You will be able to use most of the LabVIEW and MATLAB code that you have already written for Lab IV !!!

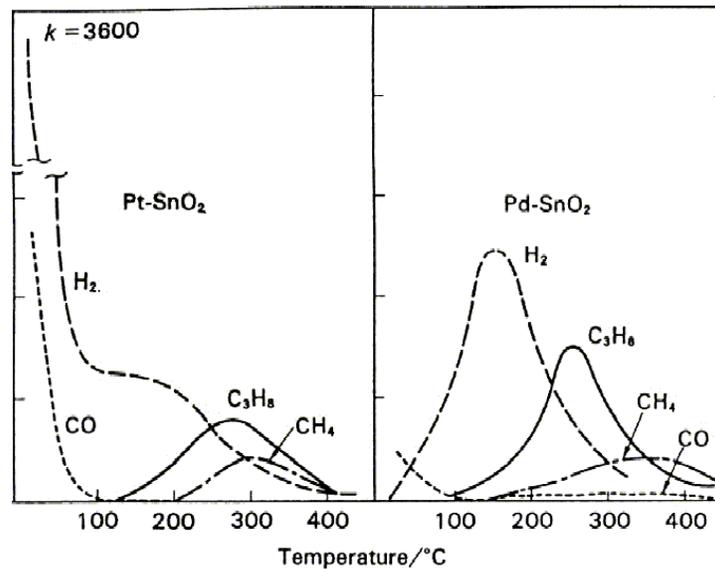


Figure 1. Selectivity-temperature profile for Pt- and Pd-doped tin-oxide sensors (from [YM92]).

IMPLEMENTATION

A number of heater profiles have been used in the literature, including sine, square and triangular waveforms [Lee99]. In this lab we will use a triangular waveform, which can be easily implemented with a software counter. You will modify your LabVIEW program¹ and use the Analog Output of your DAQ board to drive the sensor heaters. As a precaution, use a buffer to connect the H1 heater line on the left of the breadboard (inputs from the DAQ) to the H1 heater line on the right (which is connected to the heater pin of the sensor). Use the same heater line for all the sensors.

¹ Make sure you keep a backup copy of the one used for Lab 4

Figure 2 shows a possible heater voltage (V_H) profile for the wash, reference and sample stages of your sampling cycle. Voltage levels of 1V to 5V and 60-second stages are recommended. Can you generate these heater profiles without a major software rewrite?

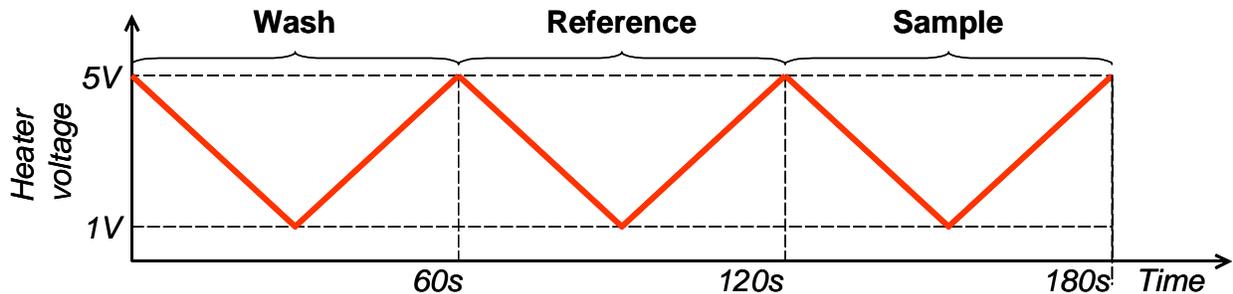


Figure 2. Temperature profile for the wash, reference and wash stages

ANALYSIS

You will only need to write new code to perform preprocessing and feature selection to take advantage of all the extra information provided by the temperature-modulated sensor responses. An easy way to generate a feature vector is to sub-sample the sensor response (as explained in Lab 4), integrating over a small number of windows (10-30) to capture the sensor response at various temperatures². Repeat sections IV and V of Lab IV and generate a brief report documenting your results.

REFERENCES

- [YM92] N. Yamazoe and N. Miura (1992), "Some basic aspects of semiconductor gas sensors," in S. Yamauchi (Ed.), *Chemical Sensor Technology*, Vol. 4, pp. 19-42.
- [Lee99] A. P. Lee and B. J. Reedy (1999), "Temperature modulation in semiconductor gas sensing," in *Sensors and Actuators B* 60, pp. 35-42.

² Notice that the increasing and decreasing ramps will not be symmetrical due to thermal inertia