Lesson: Heating Curves: Evaporating Gold in Tungsten

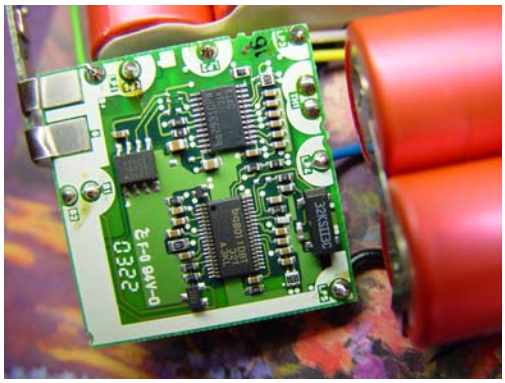
Summary

Students are reminded of the concepts of endothermic, exothermic, heating curves and introduced to the idea of phase changes along with a deepened understanding of melting and boiling points. This is done doing a simple demonstration of the heating curve of water: melting ice and then boiling the resulting liquid water in order to produce steam.

Engineering Connection

Among the steps involved in creating a microchip, there is a step that requires the evaporation and condensation of metals onto the silicon wafer. This process has to be carefully done, as most metals (including gold and aluminum) melt and evaporate at very high temperatures and therefore the material used to contain the evaporating metal needs to be able to handle the temperature that evaporates those metals. In the case detailed in this lesson, tungsten is used in order contain melting, then evaporating gold and aluminum.

Contents



Grade Level: 10 (10-12) Lesson#1 of 1
Time Required: 60 minutes Lesson Dependency: none
Keywords: Heating Curve,

Related Curriculum:

Subject area:	Chemistry
Activities	Phases of matter periodic table
	Visual portrayal of heating curve of water
	Visual demonstration of uses for evaporated gold
	Drawing Heating Curves

Educational Standards:

California Chemistry Standard
7c. Students know energy is ... absorbed when a material evaporates or melts.

Pre-Req Knowledge

Algebra: Students can draw axes, including the dependent and independent variables
Chemistry: Understanding how to use the Periodic Table, especially that the colors mean the phase of matter something is at standard temperature and pressure.

They will also understand the concept of exothermic and endothermic processes, heat transfer and heating curves

Learning Objective

Students will draw and compare the heating curves for two metals and determine what temperature range they could use to evaporate one metal while it is sitting on top of another metal or substance.

Introduction/Motivation

In order to deposit tiny layers of gold molecules evenly on a silicon chip, there is a need to evaporate the gold through what are called "masks" in order to place a pattern of the gold on a chip. This is in order to form what are called Schottky diodes, which can be used to clamp voltage, protect circuits against discharge and help rectify current in power supplies. By showing the results of this gold deposition to the students, the idea is to give them a feel for the way that this kind of evaporation and masking are used in real circuits. The students will have done a laboratory on the phase transformations of water, described as a heating curve.

Background

Heat transfer is a necessary concept for understanding that the heat applied to the water and/or gold produces a change in heat in the gold or water itself. Heating capacities will be evident in this lesson as slopes in the heating curves.

Exothermic and endothermic processes and phase transformations and heating curves are prior knowledge from labs performed earlier in the year.

Vocabulary

Heat transfer: heat flows from hot items to cold items
Exothermic: releases energy
Endothermic: absorbs energy
Heating capacity: the amount of energy it takes to raise one gram of a substance 1 degree Celsius.
Heating curve: a graph of the complete transformation from
Boiling point: endothermic phase change from liquid to gas form
Melting point: endothermic phase change from solid to liquid form
Condensation: exothermic phase change from gas to liquid form

Associated Activities

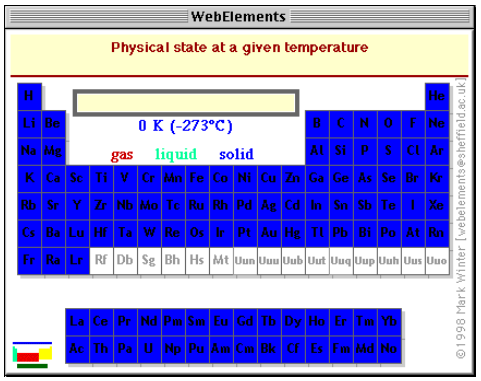
Three demonstrations:

Phases of matter periodic table

Conveying the effect of different temperatures on the phases of matter of the elements on the periodic table.

Materials needed:

.gif file



Visual portrayal of heating curve of water

Melt ice into liquid water

Then boil liquid water into steam.

Materials needed:

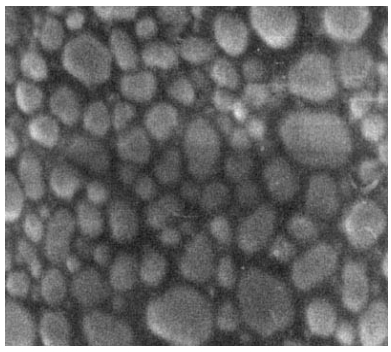
Heating device (Bunsen burner, stove or hot plate)

Large glass beaker

Ice

Thermometer

Visual demonstration of uses for evaporated gold



Place Schottky diode on document camera

Zoom in to show the shapes that were created through different masks through which the gold was evaporated

Materials:

Document camera

Projector

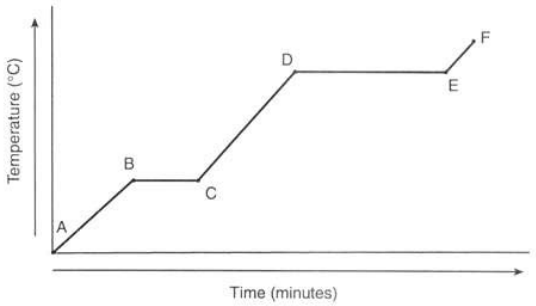
Schottky diode

One student activity:

Drawing and analyzing Heating Curves.

Students will draw the axes and the legend for a plot.

Next, they will label the heating and melting points for a particular substance.



Then, the students will place a heating curve, starting with the solid phase, moving through the melting transition to the liquid phase and on through the evaporation transition to the gas phase on this grid.

They will then repeat the above process for a second substance on the same axes.

Finally, they will answer questions based on the two curves.

Analysis:

Find a temperature range where the two elements are in different phases.

Which should hold the other in an experiment?

(Just as Tungsten held Gold in the laboratory experiment)

What other factors might you consider?

Lesson Closure

Students come up with their own application for the science and technology that they have learned in this lesson, sharing to a partner, a group and then the entire class.

Assessment

Initial assessment of students' understanding of the background knowledge through the following questions:

What do the colors on the periodic table mean?

What do black, blue or red mean?

What would happen to the periodic table if we lived on a different planet?

What did you see happen with the ice?

In order for the ice to melt, what had to be added?

How was that added?

In order for water to turn into steam, what had to be done?

Closing assessment for the lesson:

Students respond to the analysis questions regarding heating curves.

Students demonstrate good reasoning and creativity in the applications to the technology produced.

References

A. Scherer, G. DeRose, and Rutlege. (2009). Introduction to Integrated Circuits: The Applied Physics 9 Laboratory Manual.