ENGR 240 – Science of Materials Laboratory

LAB A
TRANSITION TEMPERATURES OF MATERIALS

Transition temperatures are temperatures that mark the onset of a phase change within a material. A familiar transition temperature is 0 °C – the temperature at which water changes from the liquid to the solid state (a "melting" transition temperature). The measurement of transition temperatures can be used to identify unknown materials or to characterize the structure of new ones.

Procedures

There are two components of this experiment. Both should be carried out simultaneously.

1. The melting temperature of pure compounds is a measure of the intermolecular forces that hold the solid together. Using a melting point apparatus, determine melting temperatures for the organic compounds naphthalene, anthracene, and benzoic acid. For your report, look up the molecular weights and chemical structures of these compounds and discuss how these help explain observed differences in melting temperature.

2. Several lead-tin alloys of unknown composition are contained in a pot furnace. You are to use the Vernier hardware and Logger Pro software to measure the temperature of these alloys as they cool from the liquid state (above 340 °C) to 160 °C. Temperatures for each sample should be taken at least once every minute. See your laboratory instructor for specific instructions on using the data acquisition setup.

   The Logger Pro software will record the temperature of each alloy at specified time increments. After all of the alloys have cooled to about 170 °C, stop the data collection and export your data to a *.txt file. You will use the data in the text file to generate “cooling curves” (T vs. time curves) for each of the Pb-Sn alloys. The text file may be opened using Microsoft Excel (or another graphing program).

   Transition temperatures for each sample can be identified by any abrupt change in the slope of the cooling curve, including (but not limited to) the onset of a plateau or "thermal arrest." Such changes in the rate of temperature decrease are linked to the latent heat associated with any phase change in the sample. By comparing transition temperatures with boundaries on the attached lead-tin phase diagram, try to identify the compositions of the samples. (Ex: a sample containing 30 wt.% tin should show transition temperatures at 260 and 183 °C).

References

1. Callister, Sections 9.1-9.7 (Phase Diagrams)
2. CRC Handbook of Chemistry and Physics (or another chemistry reference book)

The Lead – Tin Phase Diagram (from Callister):

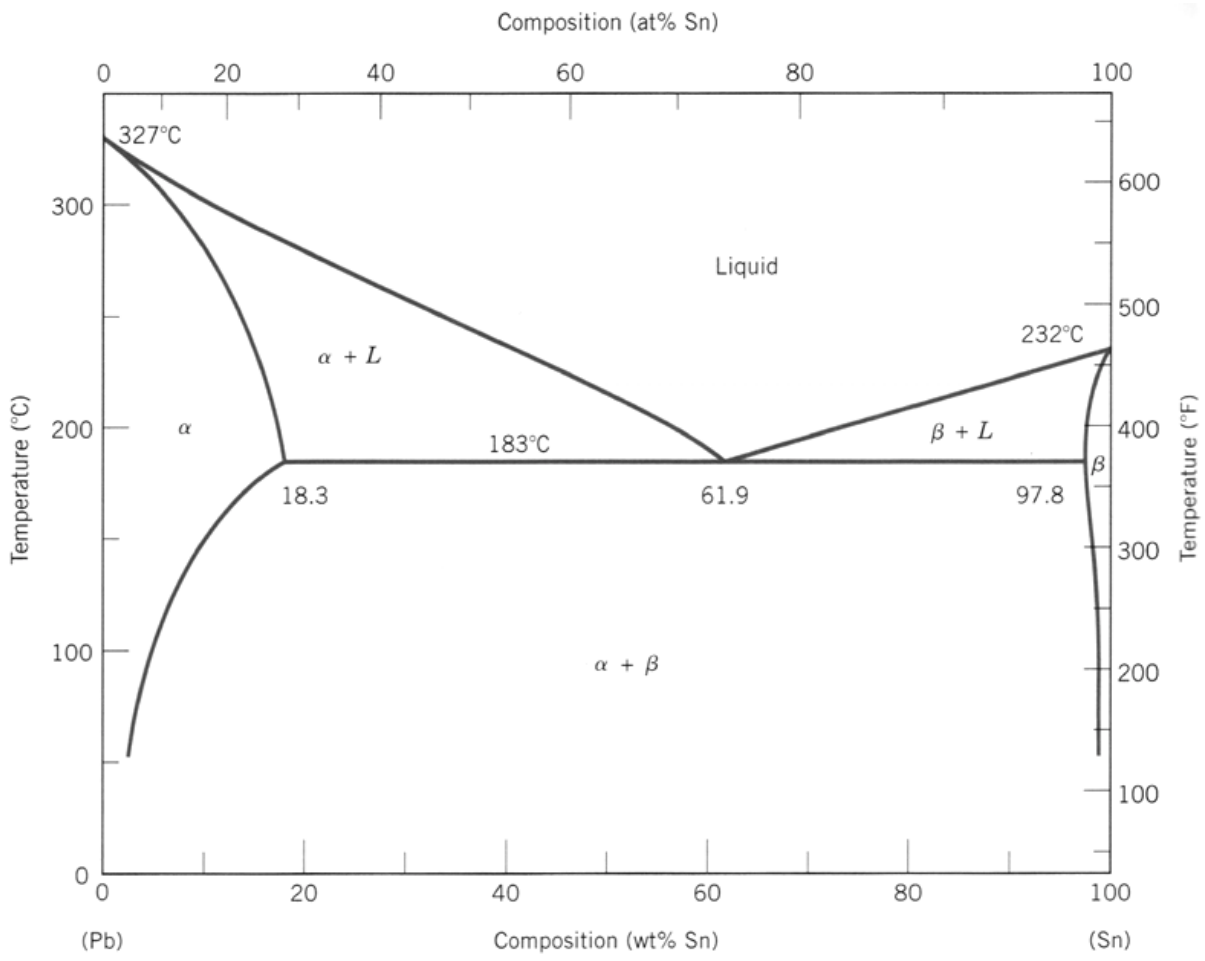

FIGURE 9.7 The lead–tin phase diagram. (Adapted from *Binary Alloy Phase Diagrams*, 2nd edition, Vol. 3, T. B. Massalski, Editor-in-Chief, 1990. Reprinted by permission of ASM International, Materials Park, OH.)