SOLID-LIQUID EQUILIBRIUM

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ABSTRACT:

The method of thermal analysis is used to determine the solid-liquid phase diagram of the tin-lead system. The cooling curves of a series of tin-lead mixtures are observed in order to plot the phase diagram of the system.

TEXT REFERENCE:

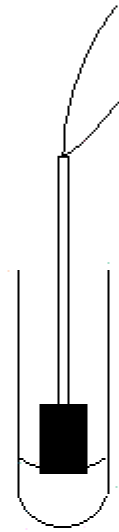
OTHER REFERENCES:

GENERAL DESCRIPTION AND THEORY:

When a mixture of two solids which are miscible in the liquid phase is heated to a liquid, the cooling curve can be used to indicate the presence of more than one phase. When a solid first begins to separate from a liquid mixture the slope of the curve will change or there may be an example of supercooling. In addition the presence of two solid phases and a liquid phase causes a temperature halt. The freezing points and eutectic points can then be plotted versus the composition to give a phase diagram, which is the object of this experiment.

EQUIPMENT:

Metal sample holders, glass jacket, Dewar for ice and water, thermocouple set and Meeker burner. The thermocouple leads are connected to a serial data acquisition device which also converts the analog signal to a digital value which is read into a computer through a data acquisition board equipped with an amplifier and an analog to digital converter.



PROGRAMS:

The LabView program Solidliq.vi is run for each run of the experiment.

CHEMICALS:

Lead and tin.

DIAGRAMS:

LABORATORY PROCEDURE:

The student will prepare seven samples for this experiment. Two of the samples consist of the pure metals (Pb and Sn); the remaining five samples are mixtures of the metals. Each sample will be contained in its own iron crucible. Each crucible is weighed empty, and then weighed as each metal is added. There should be enough sample in the crucible to yield a depth of 2 cm. It is important to know the mass of each metal in the sample in order to determine the composition (mole fraction) of that sample. The five mixed samples should be evenly distributed through the composition range. The contents of the crucible are covered with carbon (to prevent oxidation at the surface) and the sample is heated by placing it directly over a Meeker burner. When the metal sample has melted, the crucible is transferred to a glass test tube with glass wool in the bottom. The test tube is then placed in a jacket to give the desired cooling rate. Be careful in handling the molten metals they are quite hot. After the system has been assembled, a thermocouple is placed in the molten metal and the program started so that the cooling curve may be observed. The run continues until the sample has completely solidified. The LabView program will automatically convert the thermocouple output (V) into a temperature (^oC).

CALCULATIONS:

The output for each run can be loaded into a spreadsheet. A graph of temperature versus time will be examined for the arrest point, which is where the temperature remains constant. For a pure substance, the arrest point is the melting point. For a mixture, the arrest point is where the sample has completely solidified. Mixtures will also exhibit a break point, where the liquid begins to solidify. The cooling curve will have a dramatically shallower slope between the break point and the arrest point, as the solid precipitates out of the liquid. The temperatures of the arrest points and break points will be used to construct the phase diagram (T versus x) for this binary system. The phase diagram of the solid-liquid system is the principal result of the experiment. The eutectic composition and the eutectic melting point may be obtained from this diagram and should be reported. Please include each of the cooling curves in the report. Compare the melting points of the pure substances, and the composition and melting point of the eutectic with literature values.

LITERATURE VALUES: