Introduction

Differential thermal analysis (DTA) is a technique where a sample material and an inert reference are heated with identical thermal cycles. When melting, crystallization, evaporation, sublimation, a chemical reaction, or a phase transformation occurs in the sample, the sample gives off heat (exothermic) or absorbs heat (endothermic) and the sample temperature is different than the reference temperature. The DTA apparatus measures the temperature of the sample and reference and displays the difference in temperature as a function of the furnace temperature.

The DTA system consists of a furnace, a temperature controller, two holders for the sample and reference materials, each with its own thermocouple, and a data acquisition system.

We are interested in using a DTA to construct a phase diagram for the Ba-Co-Fe-As system, which contains the superconducting compound Ba(Fe_{1-x}Co_x)As_2. The problem is that As is poisonous and has a high vapor pressure. For this reason, we want a dedicated DTA system to study this system.

Since we do not have the money to purchase a new DTA, an old Perkin Elmer DTA 1700 was modified for this purpose. The furnace and sample holders were in good condition, but since it was built in the late 1980s, the electronics had to be updated.

The DTA was successfully refurbished and optimized so that LabView can be used to program the desired heating cycle and collect the data.

Procedure

- Separate DTA 1700 from Control Module and examine the wiring
- Determine which parts can be reused
- Determine how to upgrade the temperature controls so the furnace can be run by a computer interface
- Upgrade temperature controls to a Watlow Temperature Controller
- Upgrade the data acquisition device to NI cDAQ-9174 with NI 9211 Thermocouple Card
- Remove unnecessary electrical components
- Implement two 36V step down transformers in series to achieve a step down voltage of 72V from 110V
- Upgrade SSR (Solid State Relay) switch
- Write a LabView code to control the temperature profiles (cycles), which also records the data gathered from the NI cDAQ system and exports it to a MS Excel file

Results

Figure 1: Side view of Perkin Elmer DTA 1700 before refurbishing

Figure 2: Top view of Perkin Elmer DTA 1700 with original electrical components before refurbishing

Figure 3: Top view of Perkin Elmer DTA 1700 with refurbished and optimized electrical components.
   1) Step down transformers
   2) Data Acquisition Device
   3) Watlow Temperature Controller
   4) Solid State Relay Switch

Figure 4: Side view of Perkin Elmer DTA after refurbishing
   1) Furnace

Figure 5: Side view of Perkin Elmer DTA after refurbishing

Future Work

- Analyze Iron Pnictide samples
- Construct a Phase Diagram for the Iron Pnictide samples analyzed

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References
