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PC based Temperature control system for Energy Spectrometer

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Abstract

A PC based temperature control system is designed to measure, set and control the temperature of the target medium in order to measure the energy loss of charged particles in ferroelectric target as a function of temperature of the target medium. A Lakeshore model DRC-93CA temperature controller with IEEE-488 interface, Pt-100 four probe RTD sensor positioned in to the Sample Holder are used. A Microsoft Visual Basic based software package, 'Test Point' was used for developing a computer program for the desired schedule of sample temperature. The system was tested for controlling the temperature of a target sample over the temperature range from room temperature to 200^{o}C with an accuracy of ± 0.1^{o}C in the scattering chamber having a vacuum of 10^{-6} Torr. This paper reports the design of robust temperature controller and the arrangement of sample holder.

1.0 INTRODUCTION:

A reliable and accurate temperature controller are important in various fields such as medical, biological, industrial and many times in basic scientific research. The functions of a temperature controller used in our experiment can be broadly classified as a) Set-point to the desired temperature, b) sample temperature and b) Recording of Detector temperature. Depending on the nature of application, the desired accuracy can range from ±1K to even ±0.001K. One of the conventional methods of achieving this is to adopt a suitable electronic control circuitry, the design of which can be as simple as in an on-off controller or can be elaborate and complicated as a PID type of controller (1,2). For controlled cooling or heating one has to go for additional

circuitry along with the ones mentioned above. However since the beginning of this decade some unconventional methods namely fuzzy logic and neural network approaches have been fast gaining popularity (3). The salient feature of this temperature controller is to set, control and record the temperature of the sample placed in the vacuum environment and is monitored remotely using a computer. Hence to study the energy loss of charged particles in materials undergoing phase transition as a function of the temperature of the medium a PC based temperature controller system was designed to set, measure and record the temperature of the sample over a temperature range from, room temperature to 200^{o}C. In an energy spectrometer, the sample holder and the detectors are placed closely and the heating of the sample holder results in heating the detector that consequently degrades its performance. Hence apart from making arrangements to cool the detector its temperature needed to be monitored. The temperature control therefore included a sensor to measure the temperature of the detector. The system was tested for controlling the temperature of a ferroelectric single crystal sample over the temperature range from room temperature to 200^{o}C with an accuracy of ±0.1^{o}C in the scattering chamber having a vacuum of 10^{-6} Torr.

2.0 DESCRIPTION OF THE TEMPERATURE CONTROL SETUP

The sample was placed in one of the aluminum sample holder SH shown in Figure 1. Two nichrome wire heating elements of 25 Ω each were inserted into the two grooves in the SH, one on each side of the sample as shown in Figure 2. By controlling the DC current through the heating elements the temperature of the sample that was in thermal contact with the SH could be controlled. A Lakeshore model DRC-93CA temperature controller with IEEE-488 interface, supplied the required heating current and also measured the temperature of the sample as sensed by a Pt-100 four probe RTD sensor positioned in to the SH, close to the sample. The temperature of the SSBD was sensed by another four probe Pt-100 RTD sensor and was measured by a 7½ digit Keithley model 2001 digital multimeter (DMM).

3.0 SOFTWARE

A Microsoft Visual Basic based software package, 'Test Point', which is an object-oriented package that is commercially available from Keithley, was used for developing a computer program for the desired schedule of sample temperature. This Windows based package helps to create control buttons, digital panels of instruments displaying set parameters and measured parameters and strip chart records of measured parameters on the monitor of the

PC. This renders the remote control and measurement of the temperature a pleasant

task. A photograph of temperature control modules and typical displayed on the computer screen is shown in Figure 3.

At the high vacuum in the chamber, radiation was the only mode of heat loss and hence heating power of 1 Watt was found sufficient to reach up to 200^0C. With some practice of setting heater current, the system could give an accuracy of $\pm 0.1^o$C in setting and measuring the temperature over longer duration.

4.0. RESULT AND DISCUSSION:

Figure 4 show the temperature stability for 60°C as set points over a time period of 60 minutes. The temperature drift with reference to this set-points is better than ± 0.1°C for 60°C.

5.0. CONCLUSION

A versatile and reliable PC based temperature controller is developed to set, control and record the sample and detector temperature in the vacuum chamber using A Lakeshore model DRC-93CA temperature controller with IEEE-488. Pt-100 Temperature sensor are used to measure the sample temperature with an accuracy better than ± 0.1°C. The same setup is used for the energy spectrometer.

6.0. ACKNOWLEDGMENT

The author is grateful to the IUAC New Delhi personal for extending the help in writing the programming code in Visual Basic.

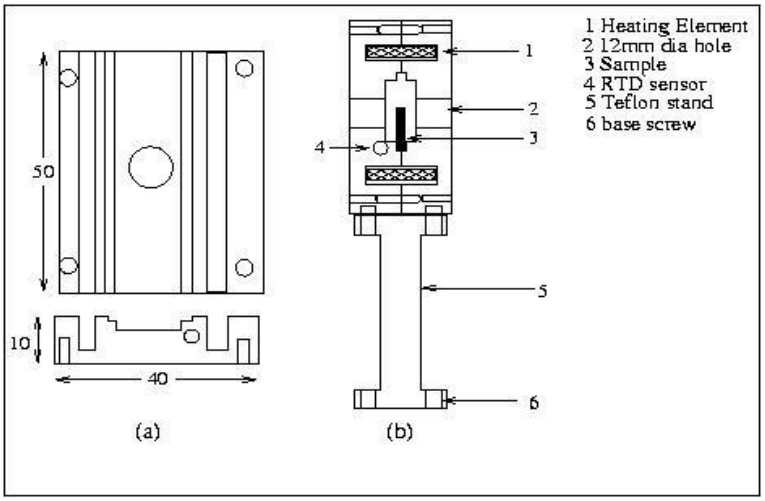
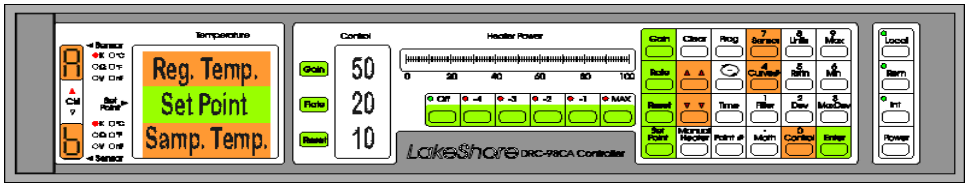


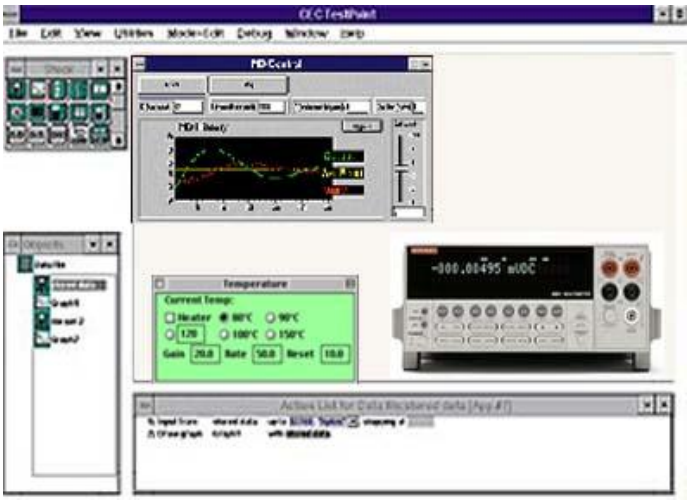
Figure 1: Design diagrams of SH and its stand

Figure 2: Photograph of SH3



(a)

(b)



(c)

Figure 3. Photograph of temperature control module (a) Lakeshore DRC-93CA to control and record the sample temperature. (b) Keithley 2001 DMM to measure and record the detector temperature. (c) Typical displayed on the computer screen

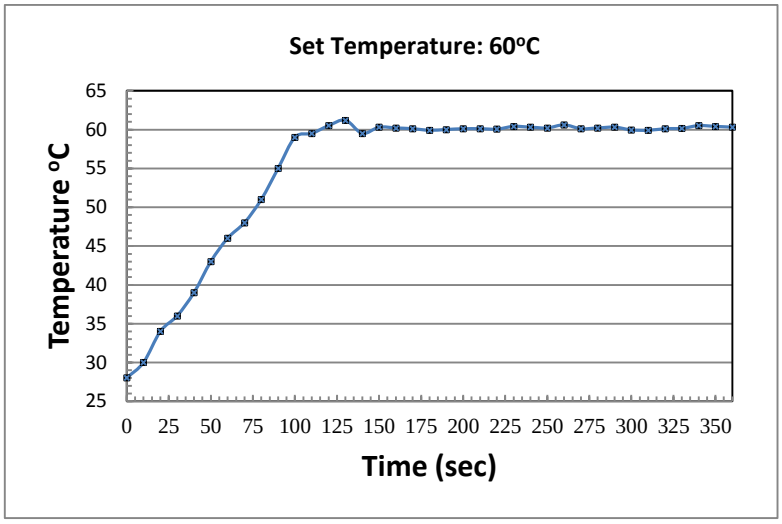


Figure 4. Performance of the controller for set point of 60°C. The sample temperature and the Set Temperature are recorded over a period of 60 minutes

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