SHOP NOTES

These are "how to do it" papers. They should be written and illustrated so that the reader may easily follow whatever instruction or advice is being given.

Temperature controller for use with low-energy electron studies of solid surfaces

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The use of various low-energy electron spectroscopies is becoming increasingly common in surface research and analysis. An experimental problem encountered frequently in such measurements is to control the sample temperature without accumulating noise due to magnetic fields, in the case of resistive heating, or due to background electron current in the case of heating by electron bombardment. Either scheme for heating the sample will render the measurements unsatisfactory. In this work, we describe a temperature-controlling scheme in which temperature control and data acquisition take place in alternating time periods.

The demands placed on the temperature controller in such a system are as follows. Temperatures commonly used range from 100 to 1000 K, with higher temperatures necessary during cleaning. Good thermal contact with a liquid nitrogen reservoir is necessary to reach 100 K. Work with clean surfaces requires that the sample cool as quickly as possible after cleaning, so the sample is placed in the lightest possible mounting. In our work, the metallic crystals are spot welded to two Ta wires and heated resistively. Currents of ~20 A are required to reach 1200 K. However, since the sample is usually quite massive (~0.5 g) and at these temperatures is cooled chiefly by conduction, a rather slow controller is adequate to maintain the sample temperature.

The temperature controller (Fig. 1) is designed to work in conjunction with a pulse counter and a parallel input/output port of a minicomputer. It obviously would work as well with a square-wave source to provide the switching and a multi-

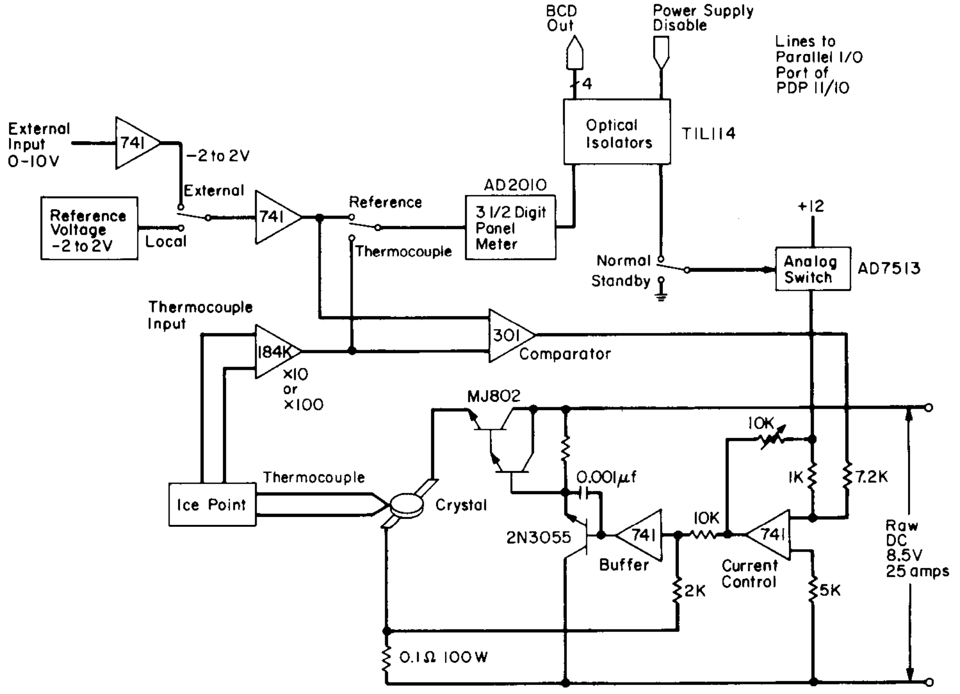

FIG. 1. Block diagram of temperature controller.

channel analyzer for data acquisition. A signal from the computer is used to disable the power supply of the temperature controller during periods in which the pulse counter is being read. During periods in which the heater is on, the spurious signal from the pulse counter is ignored by the computer. If this is used with a multichannel analyzer, the square-wave source must also be used to disable the MCA or to gate the input. In order that the crystal temperature recover quickly during the periods in which the controller is active, a comparator is used for temperature control. The heater current used to control the temperature is set by the constant-current power supply.[1]

The thermocouple EMF is conditioned by an Analog Devices 184 K instrumentation amplifier before comparison with a voltage reference. The EMF may be read on a $3\frac{1}{2}$ digit panel meter (AD2010) which is also used by the computer to acquire temperature data. An external input is provided so that the temperature also may be programmed with a ramp generator or digital–analog converter.

The comparator is an LM 301A operational amplifier designed to operate with 1 mV of hysteresis[2]. Using a W-5% Re/W-26% Re thermocouple and a gain of 100 on the input amplifier, a temperature control of $\pm 1^0$ should be possible. However, ground currents which occur during the heater operation cause an additional error, so the true accuracy is $\pm 5^0$, with heater currents of ~10 A. The analog circuitry must be isolated carefully from the high current source for the controller to function.

This controller has been used successfully in a series of vibrational energy loss measurements of oxygen adsorbed on the Ru(001) surface between 100 and 1000 K.[3] At 1000 K, the temperature controller required a duty cycle of two-thirds. The switching rate was approximately 0.3 Hz, and the temperature regulation was ±15 K. Better control is possible at higher switching rates. The heater supply may be switched at rates of 0–60 Hz.

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Modeling UHV systems with polystyrene

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A number of nonstandard UHV vacuum systems are designed and fabricated in our laboratories every year. Often these vacuum systems require many different diameter ports and flanges, arriving at odd angles to the chamber walls. There are often stringent requirements in flange tube lengths, to obtain minimum clearances.

We find it very useful to construct full-scale models of these systems before beginning detailed engineering drawings. This helps to easily visualise the construction and alleviates problems arising from interferences between different flanges, bolt holes etc. and the intersection of ports at different angles to each other. Moreover, the use of the model helps to prevent errors arising in the final engineering drawings and in the final structure itself which can be very expensive later on to alter. If however, the model itself takes a long time to make and is expensive to construct it loses much of its advantages.

We present here a simple, cheap, and fast method of construction, which we have been using for some time, using scrap expanded polystyrene as the base material. The present communication is prompted by the many inquiries and favorable comments of scientists visiting our laboratory which leads us to believe that this method of construction has not been generally applied for this purpose.

Expanded polystyrene has many advantages over the more traditional materials used in model making. It is available everywhere in laboratories from waste packing material, it is extremely light and is self-supporting. It is easy to glue and may be easily cut to all shapes and sizes. In contrast to the use of card board in model making, it requires no stiffeners and braces for support and we have found that a large complicated UHV model can be made in a very short space of time. As an example Fig. 1 shows a photograph of a model of an 18 in.

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