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A THERMOSTAT FOR PRECISE MEASUREMENTS OF THERMORESISTANCE OF SMALL SAMPLES

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INTRODUCTION

Manganin (alloy of Cu and 2.5-3.5% of Ni, and 11-13.5% of Mn) is a good and commonly used sensor of pressure in the large enough range of pressure above ~100 MPa on account of linear pressure dependence of its resistance and relatively weak temperature sensitivity of the resistance **R** (for example, [1]). But the temperature coefficient k_{Mn} of manganin resistance, $k_{Mn} = (dR/dT)R$, reveals weak dependence within too narrow interval of temperature **T** around to the room one what may cause an uncontrolled error in pressure determination. To lower such an uncertainty the possibility to extend the temperature plateau of manganin by means of high energy and high dose ion implantation has been studied [2,3] using different ion beams ($_{18}Ar^{40}$ with an energy of 1.15 MeV/u, $_{54}Xe^{136}$ at 0.87 MeV/u and $_{36}Kr^{84}$ at 210 MeV of kinetic energy) from the JINR (Dubna) Cyclotron U-300. Although our results are promising the problem of thermal stability of k_{Mn} when investigating the pressure dependence of manganin resistance turned out very important. So, first of all a particular care should be taken of the temperature stabilization of the experimental setup used for such measurements. In the work a simple computer controlled assembly fulfilling these requirements is described.

REQUIREMENTS

Operation of the computer controlled assembly ensures:

* temperature maintaining within the range of 0-100°C,
* selection of temperature intervals for measured points (1-20°C),
* selection of a number of measurements for all temperature points (1-20),
* realization of the measurements of electro-thermocharacteristics of manganin and data processing in real time,
* presentation of the obtained data and their statistical analysis in a tabular form,
* memorizing the results in a disk file,
* calibration,
* memorizing the data on the calibration in a disk file.

Moreover, the assembly should ensure long time stability of operation.

STRUCTURE OF THE ASSEMBLY

The basic circuit is shown in Fig.1. An investigated manganin slice is fixed in a holder in which the temperature sensor is mounted, too. The holder equipped in the connections to a digital multimeter (DMM) is placed into an oil thermostat. The digital multimeter is used in four-terminal resistance measurement mode. Temperature in the thermostat is established to the value depending from an output voltage of digital-analog converter DAC1. The temperature stabilization assures the controller which has been constructed specially for this assembly. In the controller a voltage coming from the temperature sensor is amplified and compared with DAC1 output voltage. As a result of this comparison the heating of the thermostat is turned on or turned off. A forward polarized silicon diode is used as a temperature sensor. Its voltage has a temperature coefficient equal to about ~2.5 mV/°C. The amplified sensor voltage outgoing to an analog-digital converter ADC gives information to the computer about the temperature in the thermostat. Output voltage from the DAC2 connected to the controller input is used as a binary signal that can enable or disable the heating of the thermostat. When the decreasing of average power of heating is needed the signal is periodically switched.

In our assembly the converters ADC, DAC1 and DAC2 are placed on the plug-in card of the computer IBM PC. The computer should be equipped in second plug-in card, an interface GPIB to read the results of the measurements of manganin slices resistance from the DMM.

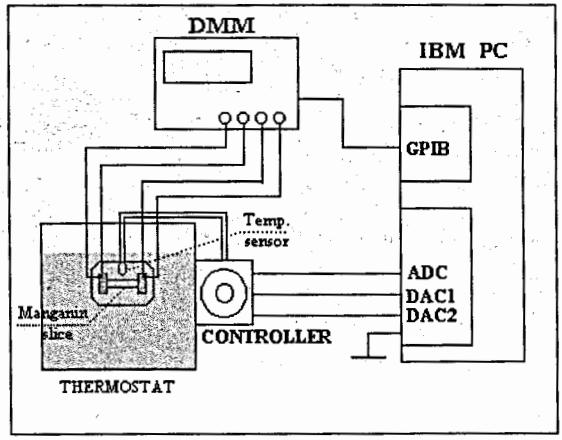

Fig.1. Basic circuit of the assembly
(explanations in the text).

References:

1. R. Wiśniewski *et al.* -High Pressures. Warsaw, 1980 (*in Polish*).
2. B. Słowiński, R. Wiśniewski. Commun.of JINR, E14-89-512, Dubna, 1989.
3. R. Wiśniewski, B. Słowiński. Commun.of JINR, E14-92-178, Dubna, 1992.

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Русиновский З., Словинский Б., Висневский Р. E13-96-485
Термостат для точных измерений термосопротивления образцов небольших размеров

В работе описан простой, управляемый компьютером термостат, обеспечивающий прецизионное определение температуры в пределах 0 — 100° С при измерении температурной зависимости сопротивления небольших образцов (2 — 15 мм) манганина, облученных в пучке быстрых тяжелых ионов.

Работа выполнена в Лаборатории высоких энергий ОИЯИ, в Институте физики Варшавского технического университета и в Институте атомной энергии (Сверк-Отвоцк, Польша).

Сообщение Объединенного института ядерных исследований. Дубна, 1996

Rusinowski Z., Slowinski B., Wisniewski R. E13-96-485
A Thermostat for Precise Measurements of Thermoresistance of Small Samples

In the work a simple experimental set-up is described in which special attention is paid to the important problem of the thermal stability of thermoresistance measurements of small samples of manganin.

The investigation has been performed at the Laboratory of High Energies (JINR, Dubna), as well as at the Institute of Physics, Warsaw University of Technology and at the Institute of Atomic Energy (Swierk, Poland).

Communication of the Joint Institute for Nuclear Research. Dubna, 1996