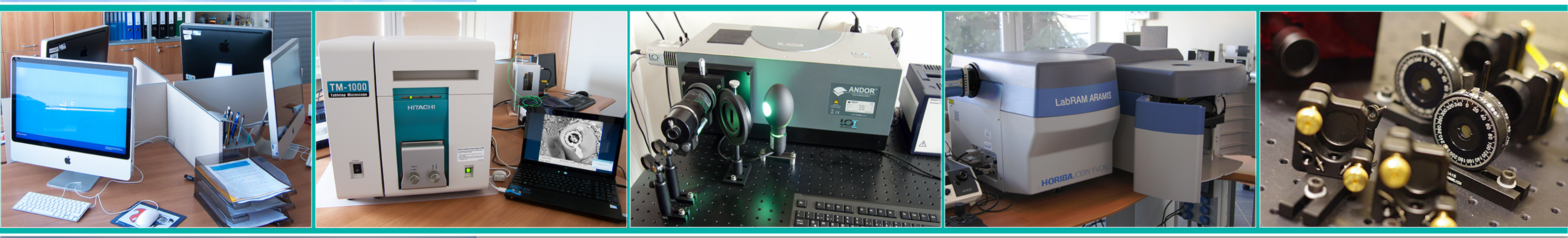
Instytut Fizyki Doświadczalnej
Wydział Matematyki, Fizyki i Informatyki
UNIWERSYTET GDAŃSKI

DLF
DYDAKTYCZNE LABORATORIUM FIZYCZNE

Experiment 28

Determining the characteristics of thermistors

KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI
UNIWERSYTET GDAŃSKI
UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ SPOŁECZNY



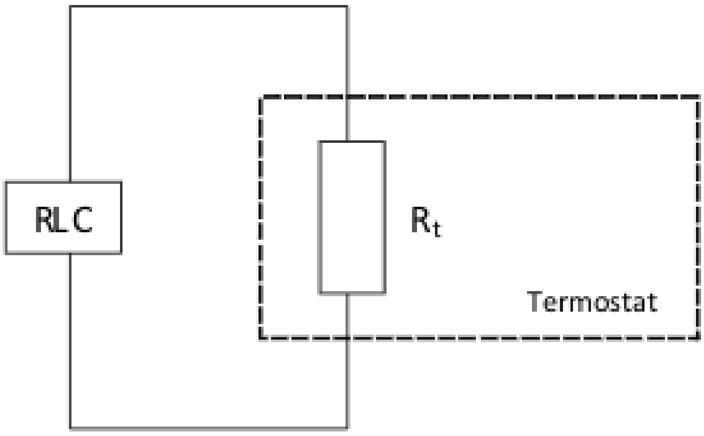
I. Background theory.

1. Energy band structure in solids.
2. The origin of band gaps.
3. Classification of solids based on band theory.
4. Resistivity temperature dependence of conductors, semiconductors and insulators.
5. Conductivity of solids.
6. Electrical conductivity of intrinsic semiconductors.
7. Thermistors :
   a) temperature – resistance characteristics;
   b) voltage – current characteristics;
   c) power - temperature characteristics.
8. Uses of thermistors.

Picture 1. Experimental setup to characterise thermistors:
1 – power supply; 2 – decade resistor; 3 – RLC meter; 4 – thermistor; 5 – thermometer; 6 – multimeters; 7 – thermostat.

II. Experimental tasks.

1. Assemble the components shown in *Picture 1* according to the diagram in *Figure 2*.



Rysunek 2. Schemat układu do wyznaczania charakterystyk opornościowo-temperaturowych: R_t – termistor; RLC – miernik RLC.

2. Present a graph of resistance – temperature characteristics for the thermistor in the range 12 ^oC to 50 ^oC with a constant temperature increase of 1 ^oC.

   To do this, place the thermistor in a water bath.

   Turn on the thermostat and controller (7 in *Picture 1*).

   When you see “OFF” on the controller, set the temperature to 12 ^oC with the arrow keys and confirm by holding the “OK” button for a few seconds.

   When this temperature is reached, measure the resistance.

   Turn off the thermostat (with the main switch).

   Continue measuring the thermistor’s resistance as a function of temperature.

   To do this, use the temperature control arrow keys to gradually raise the temperature of the water in steps of 1 ^oC, pressing “OK” each time.

   Measure the resistance for each temperature until you reach 50 ^oC. Read off the resistance using the RLC meter (by turning it on and selecting “R” with the **L/C/R** button.

   Assume a measurement uncertainty of ΔR = 0,5 %.

   Plot graphs of your results: R = f (T) and ln R = f (1/T).

   Determine the thermistor’s dissipation constant, temperature coefficient of resistance for 25 ^oC and semiconducting band gap.

3. Assemble the components according to *Figure 3*.

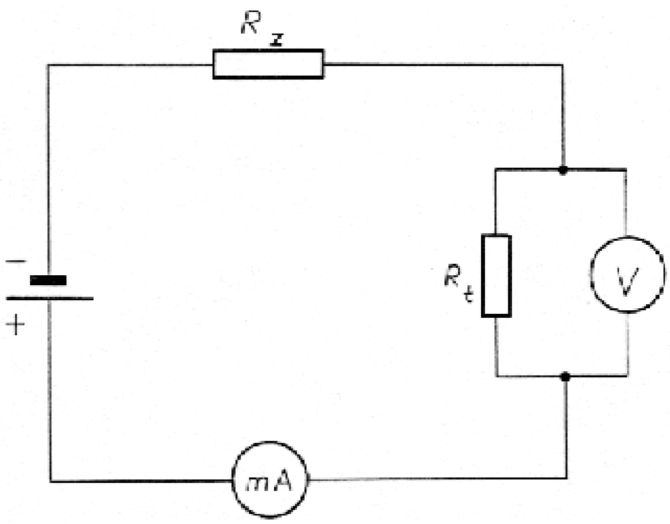


Figure 3. Circuit diagram for determining voltage-current characteristics:
R_z – safety resistor; R_t – thermistor.

4. Plot a graph of the thermistor's voltage – current characteristics.

   To do this, remove the thermistor from the thermostat.

   Set the resistance R_z for protecting the thermistor against damage (on the decade resistor) to 15 kΩ.

   Measure the voltage U as a function of current, starting from I = 0,5 mA. In the range 0,5 mA to 2 mA take steps of 0,1 mA, while for the range 2 mA to 7 mA take steps of 0,5 mA

ATTENTION!

The maximum current through the thermistor must not exceed 7 mA.

   Plot a graph of your results U = f (I).

5. Determine the power – temperature characteristics of the thermistor using the results obtained in steps 2 and 4. Present your results in a graph.
6. Discuss uncertainties.
7. Compare your results with the data given in the specifications found in the *Appendix*.

III. Apparatus.

1. Voltcraft PPS – 12008 power supply.
2. MA 2115 decade resistor.
3. Agilent 41732A RLC meter.
4. NTC – 210 semiconducting thermistor.
5. Thermometer.
6. 2 AT U 3401 A multimeters.
7. Julabo F12 – ED Thermostat.

IV. Literature.

1. A.P. Arya – “Fundamentals of Atomic Physics”, Allyn & Bacon, Inc., Boston 1971.
2. A. Moliton – “Optoelectronics of Molecules and Polymers”, Springer, 2001.
3. C. Kittel – “Introduction to Solid State Physics”, Wiley & Sons, Inc. , New York 2004.
4. H.A. Enge, M.R. Wehr, J.A. Richards – “Introduction to Atomic Physics”, Wesley 1981.

Appendix

NTC-210 thermistor specifications

Thermistor bead in glass casing

Thermistors encased in glass (*Figure 4*), with negative temperature coefficients of resistance, are used as sensors and temperature controllers as well as elements to compensate for temperature effects on electronic devices in consumer equipment and professional equipment.

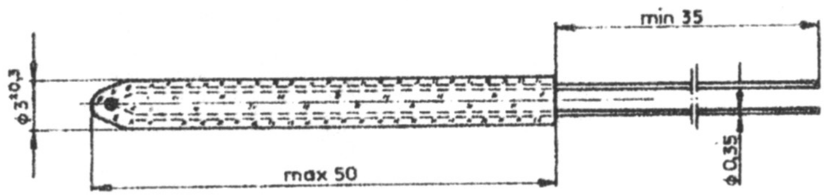


Figure 4. NTC-210 thermistor.

Specifications:

Characteristics for T = 25 ^{o}C:

1. Nominal resistance R_{25} : 10; 15; 22; 33; 47 kΩ ± 20%;
2. B-constant : 3800 K ± 5%;
3. Temperature coefficient of resistance α_{25} : - 4,3% / ^{o}C ± 5%;
4. Thermal dissipation constant K_t : 1mW / ^{o}C ± 20%.

Operating parameters:

1. Maximum power P_{max} : 175 mW;
2. Thermal operating range : -25…+200 ^{o}C;
3. Storage temperature range: +15…+35 ^{o}C.