EXPERIMENT **37**	**The Seebeck effect investigation and the thermoelectric module application for the thermal-to-electrical energy conversion.**

Instruction manual

1. **Appliance set:**
   - a measurement setup composed of the thermoelectric module, a heat exchanger immersed in the heat sink (a vessel with cold water), a copper disc, a heater and digital thermometers,
   - a digital universal meter,
   - DC power supply equipped with built-in voltmeter and ammeter,
   - a load resistor.

2. Investigation objectives: a cognition of the thermoelectric phenomena, their description, as well as:
- a determination of the dependence of the thermoelectric voltage on the temperature difference between plates of the semiconductor thermoelectric module,
- a determination of the Seebeck coefficient for the thermoelectric module,
- a determination of the dependence of a power generated by the thermoelectric module on the temperature difference between its plates.

3. Measurement setup diagram

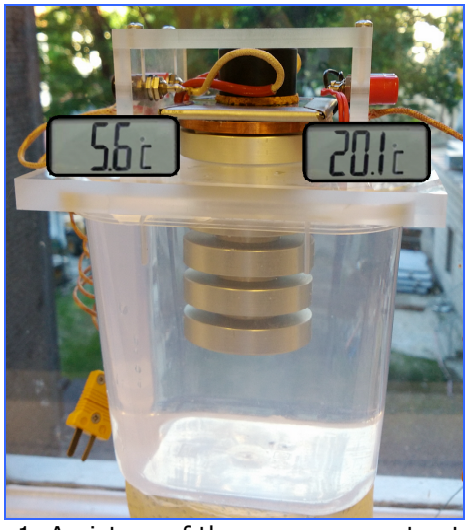

Fig.1. A picture of the measurement setup.

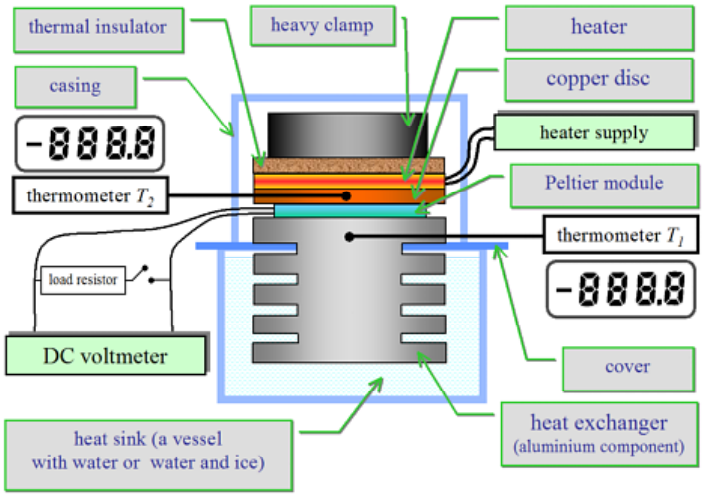

Fig. 2. A diagram for investigation of the electric current generation and for a determination of the Seebeck coefficient.

4.1. Determination of the dependence of the thermoelectric voltage on the temperature difference between plates of the semiconductor thermoelectric module.

4.1.1. Inspection of the measurement setup and interconnecting
- check a compliance of the setup elements with a listing in Point.1,
- check whether the thermometers display right temperatures,
- fill the vessel with a cold tap water up to a level of 1 or 1.5 cm below the upper vessel edge,
- place the setup in the vessel with water (Fig.1),
- connect the heater supply to the heater (bias direction is not critical),
- connect the voltmeter to the thermoelectric module output.

4.1.2. Course of the measurements

Change an intensity of the electric current flowing through the heater from 0 to 2.1 A every 0.3 A and determine the dependence of the thermoelectric voltage on the temperature difference between plates of the thermoelectric module. Each time the electric current intensity is changed, wait for 4 – 5 minutes in order to settle the temperature equilibrium. Thermometers display temperatures of the copper and aluminium components, and the thermoelectric voltage is measured with a voltmeter. Write down the temperatures of the copper and aluminium components, as well as the thermoelectric voltage.

4.1.3. Elaboration of the results

Draw a plot for the dependence of the thermoelectric voltage on the temperature difference between plates of the thermoelectric module. Determine the effective Seebeck coefficient for the investigated module, based on a linear approximation of the graph.

4.2. Determination of the dependence of a power generated by the thermoelectric module on the temperature difference between its plates

4.2.1. Inspection of the measurement setup and interconnecting

- measure a resistance of the load resistor with a universal meter before connecting cables, write down data needed for the measurement uncertainty determination,
- connect the load resistor to the thermoelectric module output and connect a voltmeter in parallel to the resistor (Fig. 2) in the setup assembled as in Point 4.1.1.
- the remaining parts do not change.

4.2.2. Course of the measurements

Change an intensity of the electric current flowing through the heater from 0 to 2.1 A every 0.3 A and determine the dependence of the voltage drop across the resistor on the temperature difference between plates of the thermoelectric module. Each time the electric current intensity is changed, wait for 4 – 5 minutes in order to settle the temperature equilibrium. Write down the temperatures of the copper and aluminium components, as well as the voltage drop across the load resistor.

4.2.3 Elaboration of the results

Draw a plot for the dependence of the electric power generated by the thermoelectric module on the temperature difference between plates of the module. Calculate the electric power dissipated by the load resistors from the following equation:

$w = \frac{U^2}{R_L}$, where U denotes the voltage drop across the load resistor R_L.

Draw the measurement uncertainty bars on the plot in three places (at the beginning of the plot, in the middle and at the end of the plot).

Compare the plot with a relation described as

$$w = \left(\frac{\alpha \Delta T}{R + R_L} \right)^2 R_L$$

where R is the module resistance, α denotes the effective Seebeck coefficient for the module, ΔT is the temperature difference between the module plates.

Authors: Ryszard Poprawski, Beata Radojewska and Wojciech Poprawski.