Laboratory Experiment

Thermocouple

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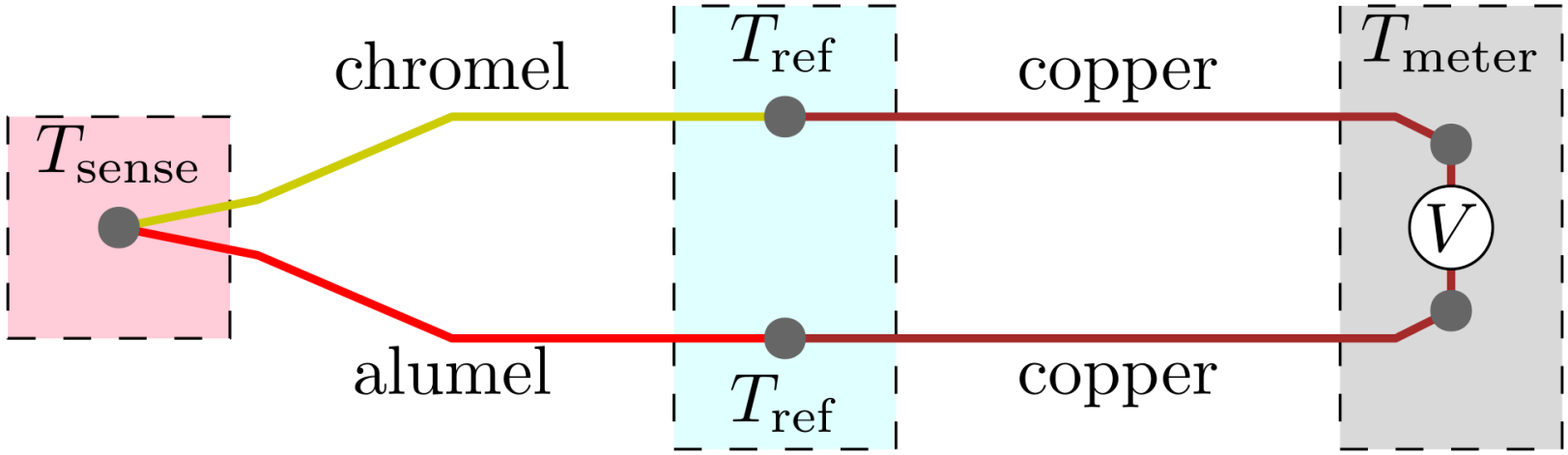
Basic principle of a thermocouple

A thermocouple is a simple device for measuring temperature based on the thermoelectric effect. The effect arises from the fact that a difference in voltage will arise at the junction between two wires of different metals. This leads to convenient handheld devices that can be used to measure temperature. Thermocouples must either have a reference built in or be calibrated.



Chromel-alumel K-type thermocouple

Example of a handheld device

The principle of a thermocouple requires the measurement of voltage. Therefore, one type of thermocouple is merely an attachment for a voltmeter. This is most useful near ambient temperature. For cryogenic applications the accuracy of the measurement requires a more sensitive voltage measurement and therefore more specialized equipment.

In the laboratory experiment we will use an analog-to-digital converter (ADC) to measure the change in voltage of the thermocouple. Once this has been calibrated the change can be interpreted in terms of temperature.

Thermoelectric effect: Seebeck coefficient

The voltage vs. temperature sensitivity of a junction of two metals can be expressed using the equation

$$\nabla V = S(T)\nabla T$$

Where ∇V and ∇T are the gradients of the voltage and temperature, respectively. $S(T)$ is known as the Seebeek coefficient. It is a material-dependent property. While there are a number of different configurations for building in a reference temperature into the circuit it is also possible to calibrate a thermocouple by dipping the tip (where the junction is) into solutions at varying temperatures to read the voltage. By obtaining a voltage vs. temperature line one can calibrate (and thereby measure the Seebeck coefficient).