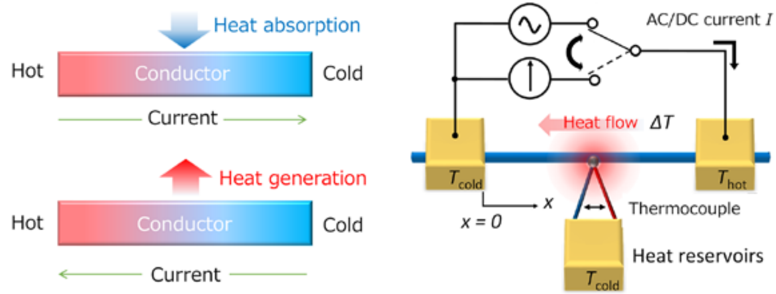
New principle for precisely measuring the thermoelectric “Thomson effect”

AMAGAI Yasutaka, SHIMAZAKI Takeshi, OKAWA Kenjiro, FUJIKI Hiroyuki, and KANEKO Nobu-Hisa

The physics and engineering of thermoelectric coolers and power generators have been studied intensively. The operating principle of these devices is based on the Seebeck and Peltier effects that convert heat into electricity and vice versa. Meanwhile, the Thomson effect is the only thermoelectric effect that occurs in a single and homogeneous conductive substance. Thus, it can be utilized to determine the absolute scale of thermoelectricity, which serves as a foundation for almost all the subsequent thermocouple-based experiments. However, the heat loss from the sample limits its accuracy and the variety of samples that can be measured. To address this issue, NMIJ has developed a new principle for measuring the Thomson effect which avoids this heat loss. A crucial idea is that most of the heat loss that occurs during the measurement of the Joule and Thomson heats can be compensated for by calculating the ratio of the two signals. Therefore, the ratio between the Joule and Thomson heats will be insensitive to the absolute amount of the heat loss. We successfully measured the Thomson effects of a fine wire and a thin film on a glass substrate with high thermal resistance, which were difficult to measure using a conventional method. This demonstrated that precise and versatile measurements were possible regardless of the shape of the sample.

Reference: Y. Amagai et al., Appl. Phys. Lett. **117**, 063903, 2020,
DOI: 10.1063/5.0018593



Thermoelectric Thomson effect (left) and measurement principle for the Thomson effect developed at NMIJ (right).