A study of Peltier effect in a thermoelectric couple of n-type cuprous oxide and p-type cuprous sulfide semiconductors

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ABSTRACT

Thermoelectricity, based on Seeback effect, Peltier effect and Thompson effect, describes the conversion of electrical energy into thermal energy and vice versa. The phenomenon of generating a temperature difference across two dissimilar metal junctions with the applied potential is known as Peltier effect. This is a reversible process and therefore it is different from Joule heating. After the development of semiconductor materials, it was revealed that Peltier effect is more prominent for dissimilar semiconductor junctions than for the dissimilar metal junctions. At present, scientists investigate the possibility of making new semiconductor materials for further development of thermoelectricity.

This study presents the investigation of Peltier effect of thermoelectric couple of n-type cuprous oxide (Cu_2O) and p-type cuprous sulfide (Cu_2S) semiconductors. These semiconductors were prepared on the two ends of a copper plate of about 1 3 cm^2 to connect electrically in series to observe Peltier effect. n-type Cu_2O semiconductor was deposited electrochemically on both ends of a copper plate and then one end was dipped in a sodium sulfide solution to prepare p-type CuS semiconductor. The thickness of the semiconductor film was about 1 μm. It was observed that the contacts were ohmic. The press contact technique was used to apply voltage to the thermoelectric couple.

It was revealed that a temperature difference was developed across the sample when a dc voltage was applied to the thermoelectric couple. Further, it was observed that the temperature difference is increased when the applied voltage is increased. The temperature difference was 30 °C for about 2 V. We have observed in the T vs. I^2 plot that the Joule heating is dominant in higher I values. In the lower I values it does not follow the Joule heating. Our observation suggests that apart from the Joule heating a significant temperature difference is established due to the Peltier effect. This work demonstrated the possibility of obtaining cooling effect by minimizing the Joule heating.