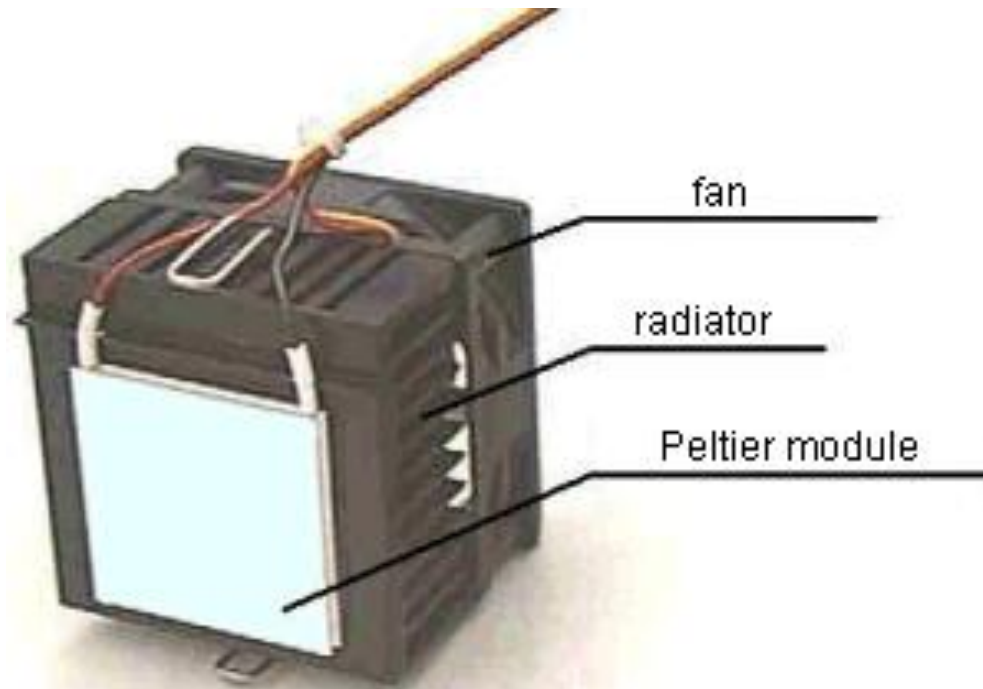


Instrumental technique (Peltier cooler)

**- Kamalesh
(08-10-2011)**

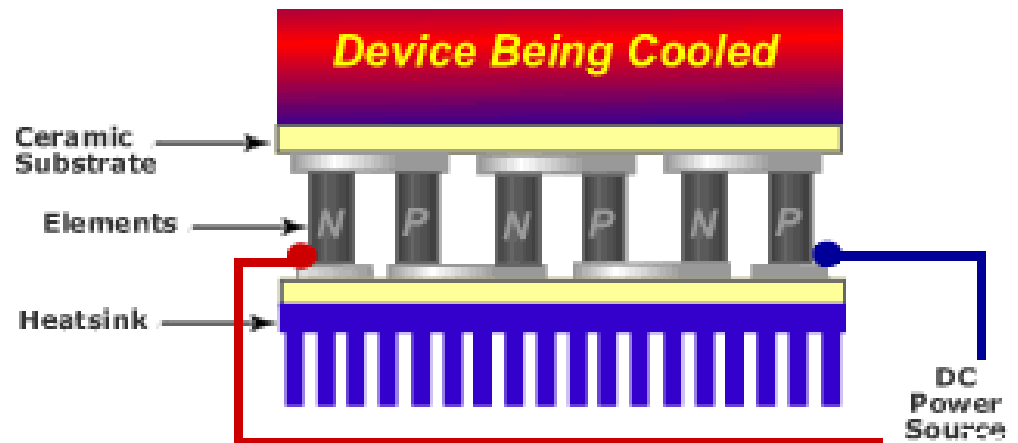
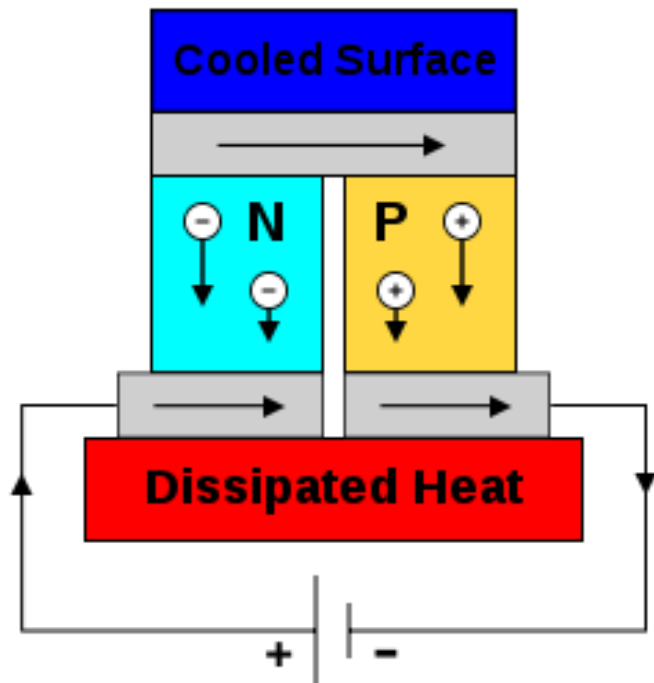
A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which **transfers heat** from one side of the device to the other side **against the temperature gradient** (from cold to hot), **with consumption of electrical energy.**

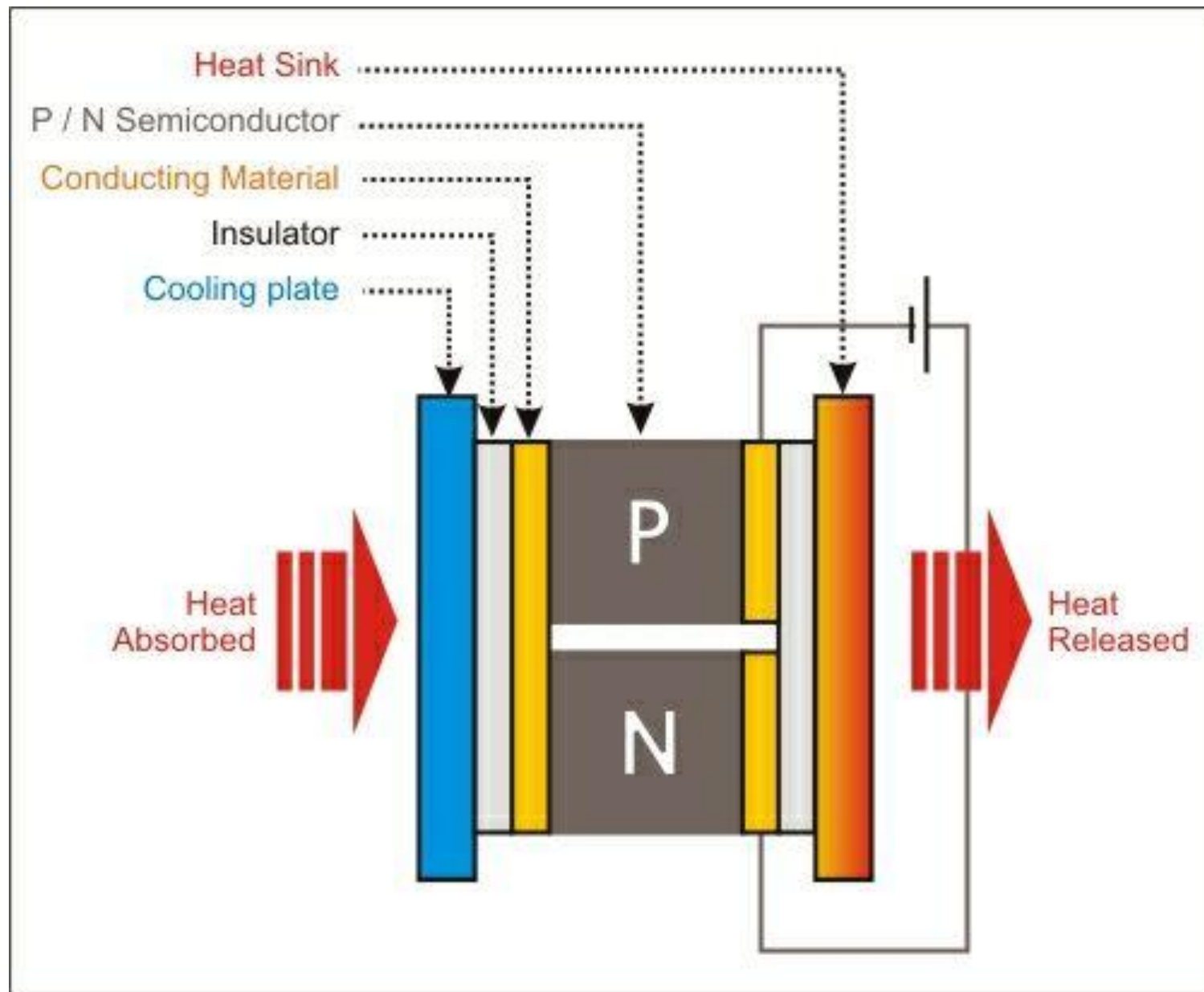


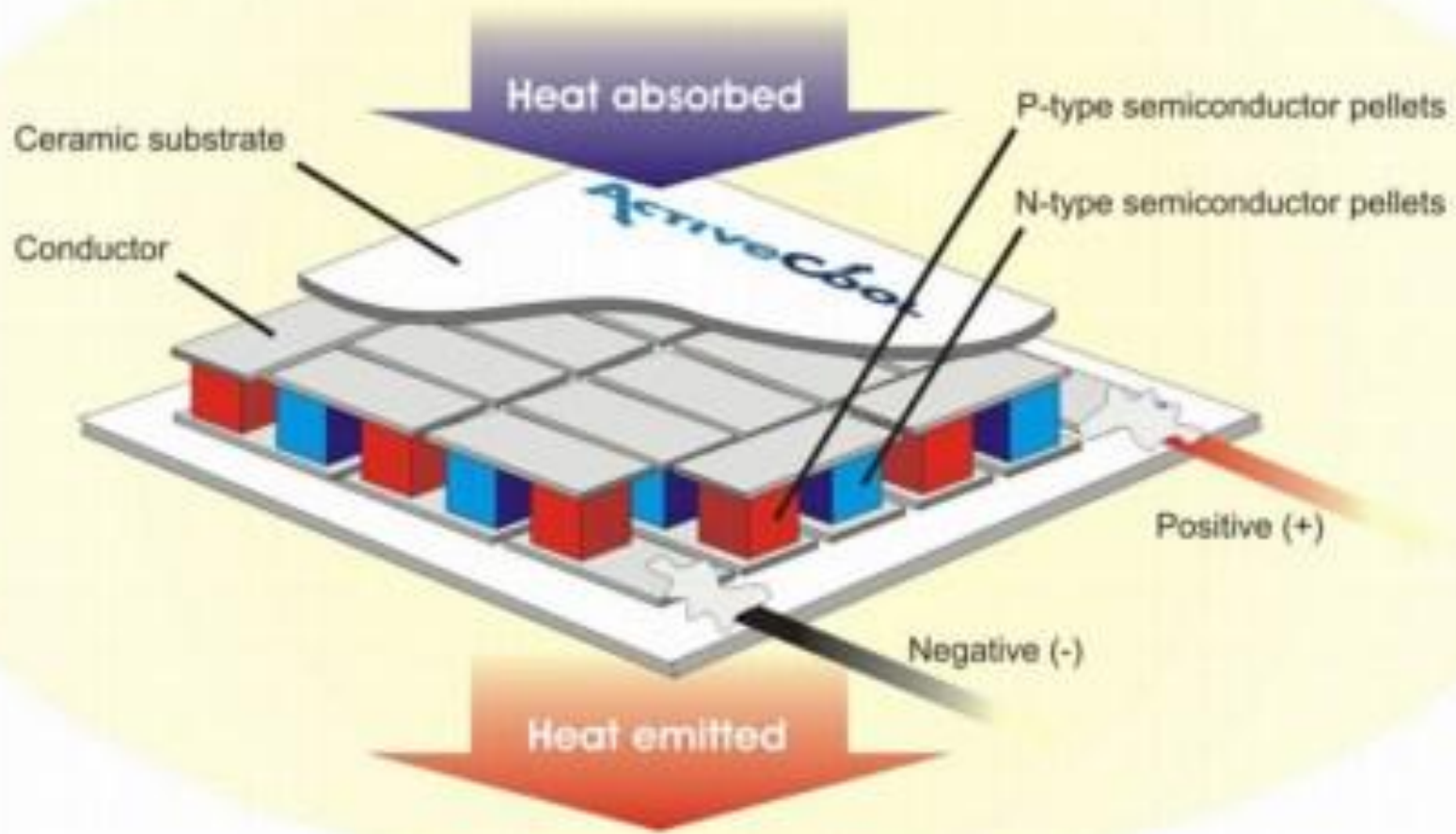
The thermoelectric effect

Peltier effect

At the atomic scale, an applied temperature gradient causes charged carriers in the material to diffuse from the hot side to the cold side, similar to a classical gas that expands when heated; hence inducing a thermal current.







Materials used for peltier coolers -

Bismuth Telluride (Bi_2Te_3)

- Due to its crystal structure, Bismuth Telluride is highly anisotropic.
- Anisotropic behavior of resistance is greater than that of thermal conductivity which can be harnessed for optimum cooling.
- Crystalline Bismuth Telluride cleaves readily along these Tellurium–Tellurium layers.

Lead Telluride (PbTe)

Silicon Germanium (SiGe)

Bismuth-Antimony (Bi-Sb)

Quantification –

The amount of heat absorbed or released at the thermocouple junction is directly proportional to the current and its duration.

$$W = Pit$$

where P is the Peltier Coefficient.

The effectiveness of a thermocouple is given a “figure of merit” designated as ZT . It is calculated as follows:

$$ZT = S^2T / r \cdot k$$

S is the Seebeck coefficient,
 T is the temperature,
 r is the electrical resistance,
 k is the thermal conductivity.

Advantages -

- 1. No moving parts. Therefore they require little or no maintenance. Ideal for cooling parts that may be sensitive to mechanical vibration.**
- 2. No refrigerants, such as potentially harmful CFCs. Therefore environmental and safety benefits.**
- 3. Enables reduced, low-noise operation of cooling fans, while providing greater cooling power.**
- 4. Suitable for manufacture in very small sizes. Therefore ideal for microelectronics.**
- 5. Lightweight.**
- 6. Long life. Exceeds 100,000 hrs MTBF (Mean Time Between Failures).**
- 7. Controllable (by voltage / current).**
- 8. Small size.**
- 9. Fast, dynamic response.**
- 10. Enhanced ration between heat sink and target element.**
- 11. Can provide cooling below ambient temperature.**

Disadvantage –

Its main disadvantage is that it cannot simultaneously have low cost and high power efficiency.