



Chapter 1 Introduction

Peltier element is a device, which is intended to transfer heat energy by absorption and dissipation. Peltier element is operated efficiently only if it is possible to ensure efficient heat absorption at one side of the device, complete transfer of the absorbed heat across the device, and efficient heat dissipation from the output side.

A Peltier element is also described as a "heat pump", it will pump the heat from one side to the other. This means that the Peltier element has a hot side and a cold side. The temperature difference between the hot and cold side is of about 70 degrees celcius, with some high performance peltier reaching up to 120 degrees celcius. Peltier element is most used for Peltier cooler which is used as cooler box.

Peltier element⁽¹⁾ consists of assembly of small semiconductor pieces mounted between two ceramic plates. This assembly is then clamped to a pair of metallic heat sink one for absorption of heat so called as "a metallic heat absorption sink" and the other for heat dissipation so called as "a metallic heat dissipation sink" and electrically insulated therefrom as shown in Fig.1.1.

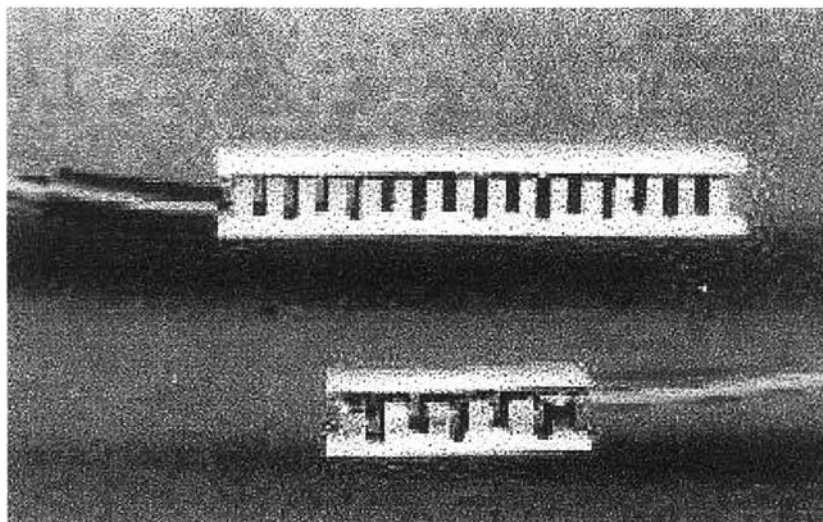


Fig.1.1 Peltier element

A microns-thin layer of an electrically conducting material “nickel pads” bonded to associated surface regions of two electrically insulating plates. An electrically conductive layer “copper pads” superimposed on each coating of electrically conducting material “nickel pads”. Many blocks of semiconductor material are disposed between the two electrically conductive layers. The electrically insulating plates are usually made of ceramics. The component parts of the entire device are bonded together as a consolidated structure, as shown in Fig.1.2.

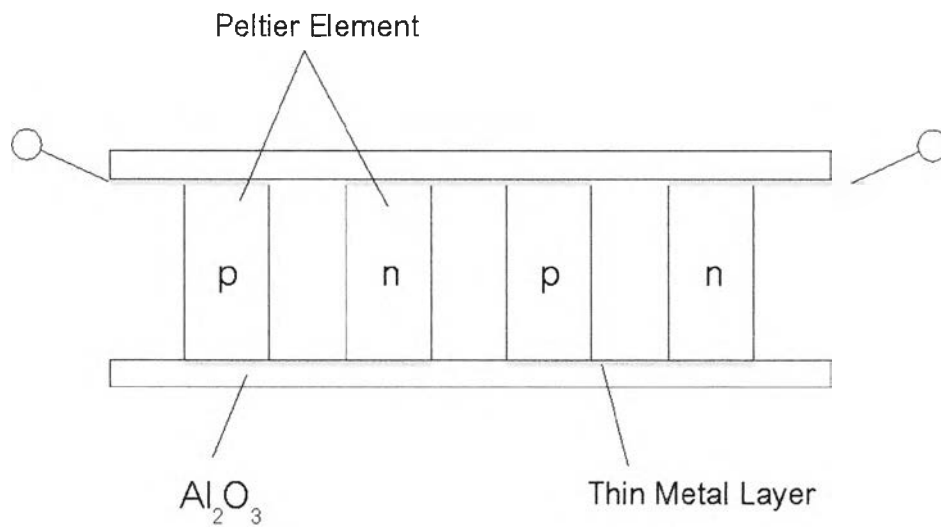


Fig.1.2 Structure of Peltier element

The ceramic plates provide a mounting support for the semiconductor assembly and electrical insulation from the metallic sinks. In order to afford sufficient strength, this strength is mainly in compression and the device is extremely vulnerable when subjected to shear force. Alumina is mostly used as a ceramic plate for Peltier element because of its electrical insulation properties without significantly loss of thermal conductivity. Alumina substrate used electrically insulated between both side of the heat sink. The substrate should have excellent heat conductance, high mechanical strength and cheap cost as well.

This research was conducted as the contract research with AISIN which is a big Japanese company, produces "Peltier element". The objective of this research is to improve the efficiency of "Peltier element" through improving the thermal conductivity of alumina substrate. Alumina which is currently used for AISIN "Peltier element" has thermal conductivity of about 24 W/m·K. The thermal conductivity of single crystal Al₂O₃ is about 40 W/m·K. So there is possibility to improve thermal conductivity of Al₂O₃ substrate.

The objectives of this research are the followings :

1. Improving thermal conductivity of alumina ceramics over 30 W/m·K.
2. Mechanical bending strength should be as high as 400 MPa.