Thermopile
IPC-4652-W

Introduction

A thermopile is made up of a number of thermocouple junctions connected in series to make a sensitive heat detecting device. If the sensitive area of the thermopile is directed towards a hot body (eg a Leslie cube), the heat emitted from the body causes the thermopile to generate a voltage proportional to the amount of radiant heat detected.

Description

The thermopile contains 36 junctions made of evaporated bismuth and antimony. The miniature multijunction thermopile is housed in a transistor type package which has a high resistance to both mechanical and thermal shock. The thermopile element is mounted on a 90mm rod with a 500mm cable terminated with red and black 4mm plugs allowing easy connection to a suitable galvanometer or millivoltmeter. The thermopile will detect the heat from a hand passed in front or can be used for experiments and demonstrations with laboratory radiant heat sources.

Experiments

Comparison of heat radiation from the different faces of a Leslie cube

1. Connect the thermopile to a suitable galvanometer or millivoltmeter. Using a clamp and stand position the thermopile a fixed distance from the Leslie cube.

2. Fill the Leslie cube with hot water and note the galvanometer or millivoltmeter reading with the thermopile directed at each face. Care must be taken to ensure that the cube-thermopile distance remains constant for each reading taken.

3. It will be seen that the largest reading is produced with the thermopile directed at the matt black surface of the cube and the smallest reading is gained at the polished metal surface. (At the matt black surface a voltage reading of approximately 8.0mV can be expected at a distance around 50mm with the cube temperature at 90°C). This shows how different colours and finishes differ in their efficiency at radiating heat. Good results will be obtained at distances around 100mm. This will give approximately half-scale deflection with the galvanometer set to 120 div/µA. In some cases spurious readings can occur due to differing surface textures. A rough textured surface of a particular finish will produce a greater reading than a smooth surface of the same finish due to having a greater surface area over which to radiate heat.

Demonstration of the inverse square law for heat radiation

1. Coat one of the faces of a large metal can with matt black paint.

2. Fill the can with hot water and position the thermopile to face the blackened side. Connect the thermopile to a suitable galvanometer or millivoltmeter.

3. Move the thermopile towards and away from the can and note that the reading remains constant as long as the surface of the can occupies the whole field of view of the thermopile. NB: the thermopile has a field of view of 80 degrees so this demonstration will yield the best results with a large can and at small can-thermopile distances.

4. The area of the can from which radiated heat reaches the thermopile is proportional to the square of the distance to the thermopile. As the thermopile output is constant when the distance is altered (within limits, see 3 above), the total heat radiated from each element of the surface of the can must decrease in direct proportion to the square of the distance from the thermopile. This demonstrates the inverse square law for heat radiation.