May 3, 2021
Thermoelectric Energy Recovery Panels

Summary

Sparatech LLC is proposing to bring a revolutionary concept for recovering energy from thermal heat sources that would otherwise be lost. The excess heat energy is converted to electricity that can be used as a supplemental energy source to provide power for other electrical devices, such as fans and blowers, or stored in batteries for later use.

Thermoelectric devices are not new as devices that generate electricity. It has been known since 1851 that the Seebeck phenomenon produced an electrical voltage in the presence of a thermal differential existing in the temperature of two dissimilar metals. SparaTech has been developing a working prototype since 2016 and now has a proof of principle unit. The manufacturing processes embodied in the functional concept as well as all of the design principles envisioned for the production modules are readily patentable.

Normally a Proof of Concept (POC) endeavor yields an elemental device that establishes the validity of the first principles of operation. We are pleased to announce that this effort has yielded a prototype device that validates both the first principles of operation as well as a proven manufacturing process.

The following has been achieved with this milestone;

- A functional prototype of a thermoelectric device system operating on a glass substrate were manufactured and tested.
- These thermoelectric devices were produced on a glass substrate of 100 mm x 100 mm. (~4" x 4")
- Glass substrates were chosen as they are readily available, inexpensive, have good thermal properties and can be laser machined for added cooling channels, if desired. Ceramic substrates are also applicable for some applications.
- Large cooling areas, essential to efficient operation, attached to the thermoelectric device junctions was achieved.
- Previous patent analysis indicates that there does not exist a thermoelectric device concept embodying the principles outlined herein. This hardware demonstration paves the path for a novel process/design patent.

Further technical detail is provided in the following text. The generalized layout principles of the functional, proof of concept, thermoelectric conversion device panel are as shown in figure 1. The layout is not to scale as approximately 136 devices were applied to the 4" square substrate. It is projected that the next series of substrates will double the number of active devices. Note that the thermoelectric junction, which produces a DC Voltage, is the small circular center area. The larger rectangular areas constitute the "cooling" area of the array system. The temperature differential producing the power output is the difference in temperature between the circular area and the rectangular areas.

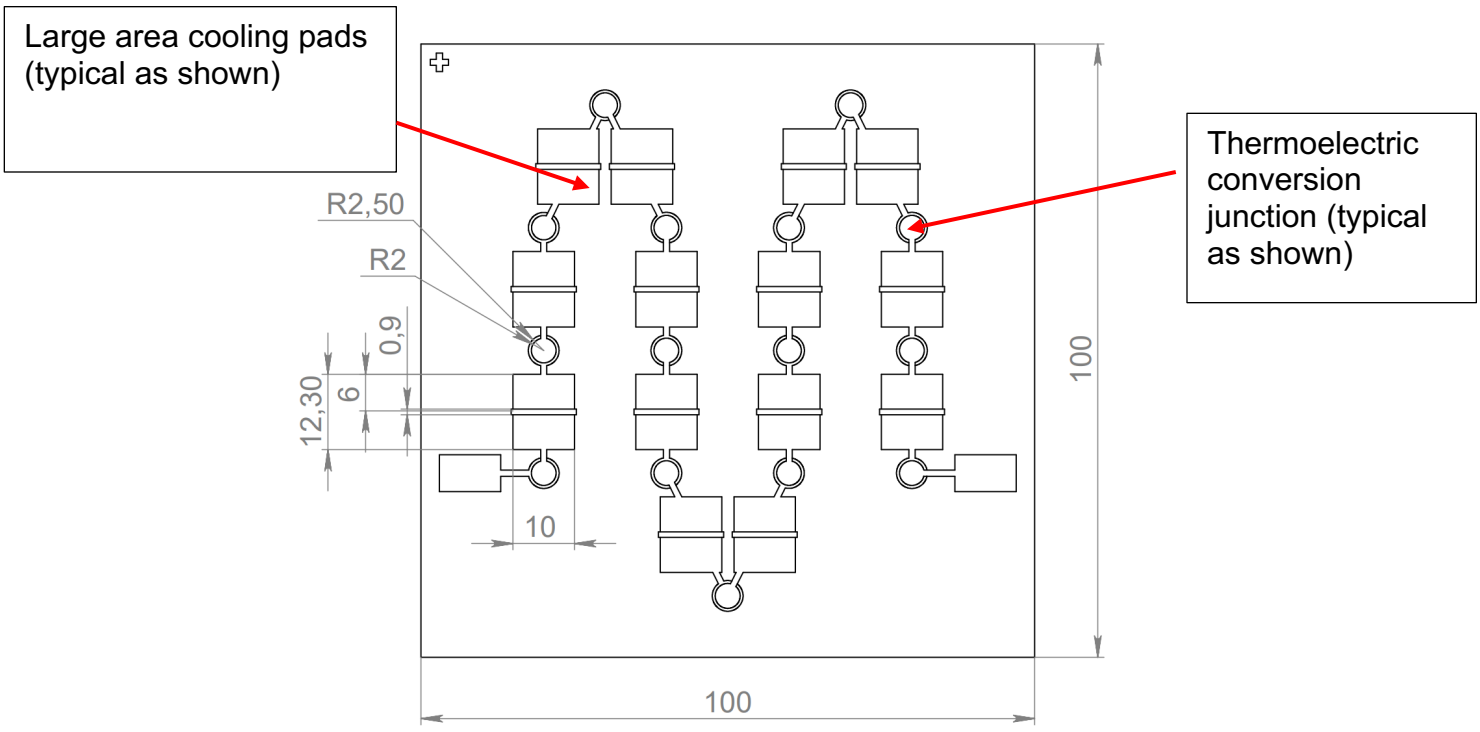


Figure 1: Design Intent Drawing

The actual hardware circuit achieved is shown in Figure 2, below:

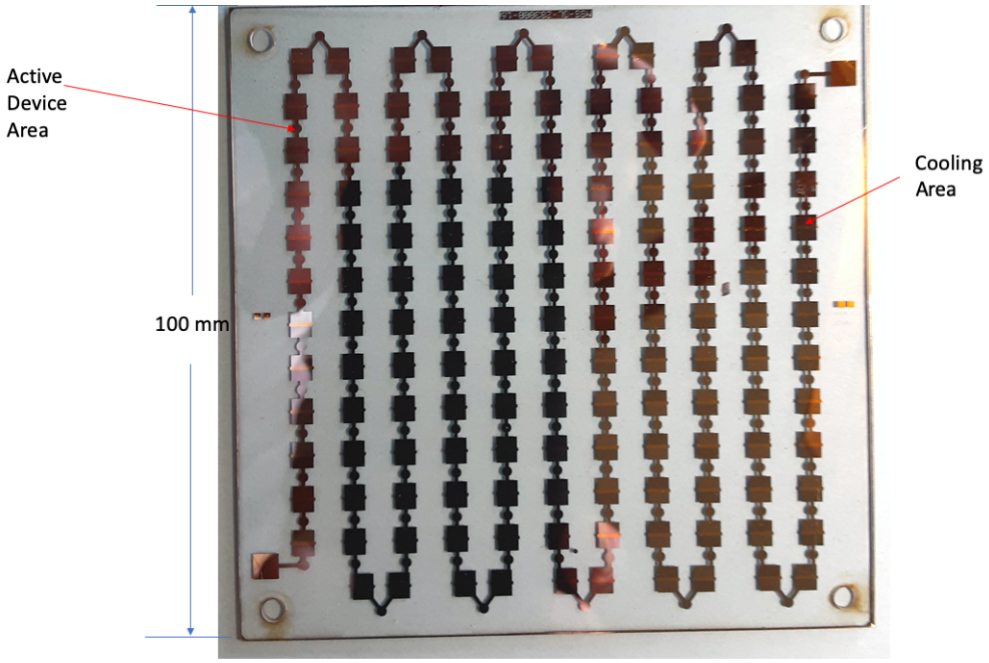
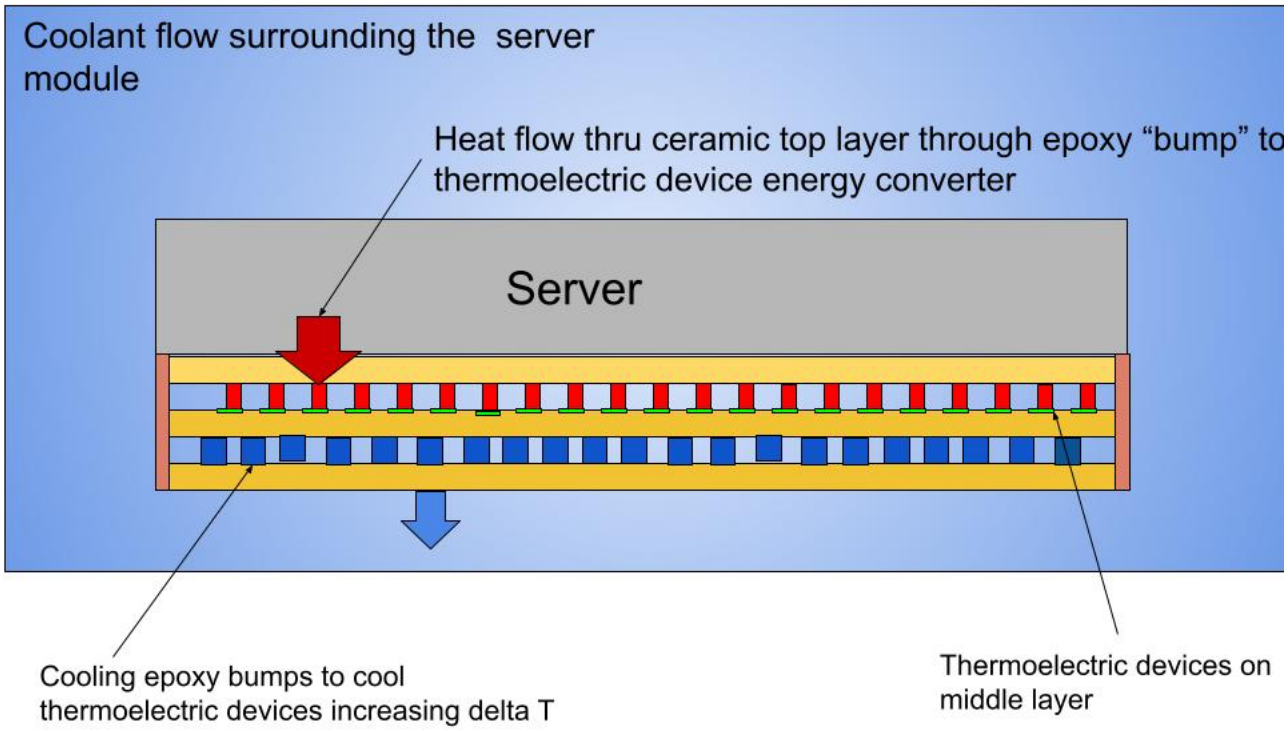


Figure 2: Active Element Layer

The picture (Figure 2) is of actual thermoelectric devices placed on a glass substrate for testing. They function as predicted. Each individual thermoelectric device should be characterized as a battery of small DC voltage which is multiplied by the number of junctions to determine total energy recovered.

Each single thermoelectric device generates 50 microvolts per degree Centigrade of temperature differential between the input heat and the cooled substrate layer. Servers are normally cooled by immersion into a container through which coolant is flowing, thus carrying off the heat generated by the electronics contained within the server. This process is effective in cooling the server. However, it constitutes additional cost and negative environmental impacts as the coolant consumes additional energy in order to achieve the lower temperatures required to cool the servers. The thermoelectric system will remove a small portion of this server generated heat. However, its primary benefit is that it generates DC power that can be used to offset the energy costs associated with coolants.

In Figure 3, below, a rendering of this concept is shown.



Inclusion of the thermoelectric devices layer recovers a portion of the wasted energy by virtue of the heat passing through the thermoelectric device layer from which DC energy is generated with no additional cost. The thermoelectric device layer has a fixed layer of thermally conductive ceramic or glass onto which thermally conductive epoxy layers are fixed. These small "bumps" are in direct contact with each individual thermoelectric device and heat the operating junction. Electrical energy is generated at each junction. This layer also incorporates larger cooling pads which act to cool the

active layer junctions (as shown in shown in figure 1& 2). Epoxy “bumps” on this layer transfer the heat to the third layer which is cooled by the normal flow of server coolant. The higher temperature thermoelectric devices generate electricity in direct proportion to the delta temperature between the junctions themselves and the cooling areas. This unit is sealed completely and simply placed in contact with the hot server and immersed in the existing coolant flow.

The thermoelectric system is shown in larger than required proportions for clarity. In actuality this entire system is approximately 3-5mm thick.