

Product and Technology Overview

Background

More features, higher speeds and miniaturization are all contributing to an increase in heat emanating from our electronics. The heat generated in these dense electronic systems, particularly microprocessors, lasers and photo detectors, can be quite large and has in-turn led to significant increases in on-chip and package temperatures that have reduced or limited the performance of such components and systems.

In addition, as energy costs continue to skyrocket, system efficiency is becoming an increasingly important attribute across all market segments. Extracting waste heat from a system and converting some percentage of that heat into usable energy is one way in which to improve system efficiency.

What do these issues have in common? Microscale cooling, thermal and power management products from Nextreme Thermal Solutions are capable of addressing both of these critical design challenges using embedded thermoelectric cooler (eTEC) and thermoelectric power generator (eTEG) thin-film modules, built from the same technology. These modules use what's called the *thermoelectric effect* to cool or heat objects, and to generate electricity.

Core Technology

At the core of Nextreme's thin-film modules is the thermal copper pillar bump, also known as the "thermal bump," made from thermoelectric materials embedded in solder bumps. Unlike conventional solder bumps that provide an electrical path and a mechanical connection to the package, thermal bumps act as solid-state heat pumps and add thermal management functionality locally in an electronic package or subsystem. With a diameter of 238 microns and a height of only 60 microns, the extremely small size of a thermal bump enables truly novel applications of thermoelectric devices.

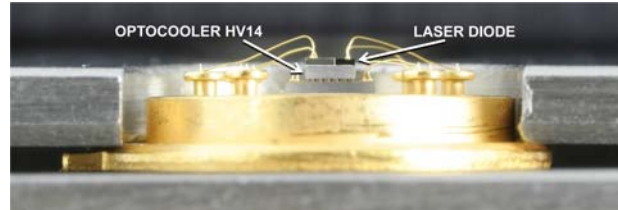


An array of thermal bumps in manufacturing

The thermoelectric material responds differently depending on the application. For cooling or heating applications, a voltage is applied to the device creating a temperature difference across the device (termed the Peltier effect). The heating and cooling mode is controlled by the direction of current flow and the sign of the majority electrical carrier in the thermoelectric material. To generate electricity from heat, the thermoelectric effect creates a voltage when one side of the device is hotter than the other (known as the Seebeck effect).

Cooling at the Source of the Heat

Whether it's a need to cool a hot spot, maintain operating temperature ranges for optimal performance or channel heat away from sensitive electronics, Nextreme's embedded thermoelectric cooler (eTEC) technology enables precision temperature control of critical electronic components. The technology is available today through the use of discrete modules.

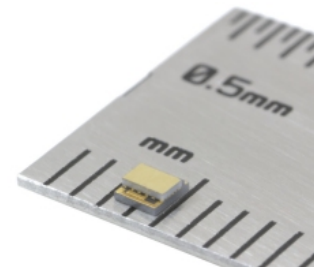


The OptoCooler HV14 cooling a laser diode in a TO-56 package

The eTEC OptoCooler™ modules are ideally suited for the cooling and temperature control of higher wattage devices such as high-brightness LEDs. For example, Nextreme's OptoCooler UPF40 module can pump a heat density of up to 72 W/cm² at 25°C, and as a result, it can move a maximum of 3.7 W of heat with an active footprint of 5.1 mm². Custom coolers with higher wattages and larger formats are also available.

Generating Power from Waste Heat

Energy harvesting, or energy scavenging, is the process whereby a portion of energy is removed, captured and stored from an existing source of unused but available energy. The use of thermoelectrics, in which a temperature difference creates an electric potential, can convert waste heat from thermal sources into usable electricity.



eTEG™ HV14 thermoelectric power generator

Converting temperature differences of as little as 5°C into electrical energy, Nextreme's eTEG UPF40 delivers a power density of greater than 300 mW/cm² and can be easily scaled by assembling the devices into large arrays depending on the application requirements.

The eTEG™ HV14 has demonstrated output power levels of >16mW at ΔT of 70°C and >45mW at ΔT of 120°C. With modules measuring just 1.8mm x 1.5mm, the eTEG HV14 has corresponding output power densities of ~ 0.6 and 1.6W/cm².

Summary

Nextreme offers the world's smallest devices with the highest available heat pumping capability available on the market today. Nextreme's semiconductor-based processes enable a new pathway into high-volume, low-cost production for new cooling and power generation applications.

For more information, visit www.nextreme.com, or in Europe www.nextreme.eu.