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Laird Engineered Thermal Systems Application Note

Thermoelectric Modules and Assemblies for Medical Laser Cooling Applications

March 2017

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Introduction

Medical lasers are designed for use in hospitals, outpatient surgical centers, and physician offices. They combine cutting, ablation, and coagulation properties for precise, virtually bloodless procedures; minimizing thermal damage to the surrounding tissue and increasing recovery time. They also sanitize the area through the heat of the laser, destroying any microbiological bodies that could lead to infection. Although medical lasers are valuable to many medical treatment applications, they do generate waste heat that affects the lasers performance when in operation. They also have size constraints, power consumption requirements, and noise restrictions that make thermal management difficult.

Thermoelectric Modules

Thermoelectric Modules (TEMs) are solid-state heat pumps that require a heat exchanger to dissipate heat via the Peltier effect. During operation, DC current flows through the TEM to create heat transfer and a temperature differential across the ceramic surfaces, causing one side of the TEM to be cold, while the other side is hot. A single-stage TEM can achieve temperature differentials of up to 70°C and transfer heat at a rate of up to 150 watts. In order to increase the amount of heat pumping capacity, the TEM's modular design allows for the use of multiple TEMs mounted side-by-side, which is called a TE array.

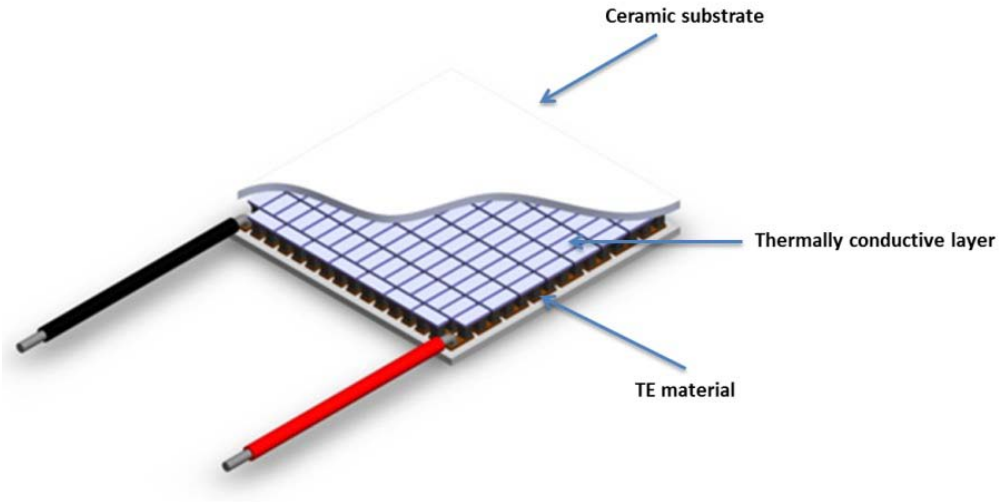

Figure 1 Cut out of a TEM device

TEMs are composed of two ceramic substrates that serve as electrically insulating materials and house P-type and N-type semiconductor elements. Heat is absorbed at the cold junction by electrons as they pass from a low-energy level in the P-type element onto a higher energy level in the N-type element. At the hot junction, energy is expelled to a thermal sink as electrons move from a high-energy element to a lower-energy element.

Reversing the polarity changes the direction of heat transfer. TEMs are rated at maximum parameters (ΔTmax, Imax, Vmax, and Qmax) under no load conditions, with temperature control accuracy achieving ±0.01°C under steady-state conditions. They can cool to -100°C (6-stage) and pump up to 15 watts per centimeter square of heat, with higher heat pumping capacities achieved by wiring TEMs into an array. Their geometry can vary from 2x2 mm to 62x62 mm and are much more efficient in heating mode than resistant heaters. They also fit into tight geometric space constraints and can be mounted in any orientation that cannot accommodate a much larger compressor-based system.

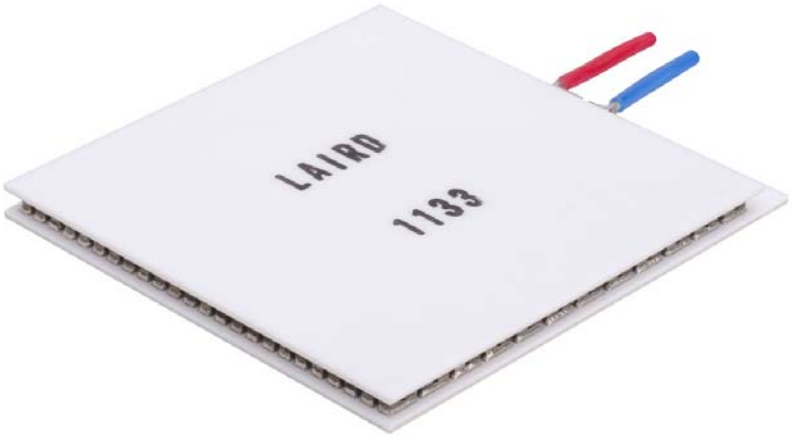

Figure 2: Laird UltraTEC Series pumps between 69 and 341 watts of heat

Thermoelectric Assemblies

Thermoelectric assemblies (TEAs) are cooling and heating systems that use thermoelectric modules (TEMs) to transfer heat by air, liquid or conduction methods that include integrated temperature controls. TEAs remove the passive heat load generated by the ambient environment in order to stabilize the temperature of sensitive components used in medical lasers.

Laird Direct-to-Air Tunnel Series

Laird Air-to-Air Tunnel Series

Laird Direct-to-Air PowerCool Series

TEAs are designed and manufactured to strict process control standards and pass/fail criteria, assuring that our customers receive the best possible TEAs. Our standard product portfolio includes an extensive array of thermal management solutions that cover a wide range of cooling capacities with compact form factors and high coefficient of performance. The standard product offering includes heat transfer mechanisms designed to absorb and dissipate heat by convection, conduction or through liquid heat exchangers. All products are manufactured in an ISO 9001:2008 certified facility.

Since there are so many attributes that need to be ascertained for each application, often a customized TEA will yield a more optimal thermal solution. Laird offers strong engineering services with a global presence that supports onsite concept generation, thermal modeling, thermal design and rapid prototyping. We also offer validation test services to meet unique compliance standards.

Conclusion

Thermoelectrics provide good temperature stabilization to maintain peak performance of a medical laser and offer solid-state operation, low maintenance, and long service life. Thermoelectrics also make an excellent thermal management solution due to compact size no vibration and low total cost of ownership. This cannot be accomplished by any other means without a complex heating and cooling system.

About Laird

Laird is a global technology business focused on enabling wireless communication and smart systems, and providing components and systems that protect electronics. Laird operates through two divisions, Wireless Systems and Performance Materials. Wireless Systems solutions include antenna systems, embedded wireless modules, telematics products and wireless automation and control solutions. Performance Materials solutions include electromagnetic interference shielding, thermal management and signal integrity products. As a leader in the design, supply and support of innovative technology, our products allow people, organizations, machines and applications to connect effectively, helping to build a world where smart technology transforms the way of life. Custom products are supplied to major sectors of the electronics industry including the handset, telecommunications, IT, automotive, public safety, consumer, medical, rail, mining and industrial markets. Providing value and differentiation to our customers through innovation, reliable fulfilment and speed, Laird PLC is listed and headquartered in London, and employs over 9,000 people in more than 58 facilities located in 18 countries.

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Contact Laird Engineered Thermal Systems

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