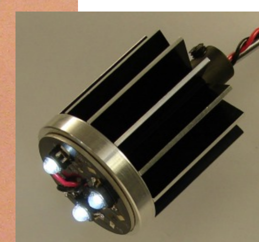
Technology Strategy Board
Driving Innovation

Advances in heat sink performance with DMLS

Innovation results

AN R&D CASE STUDY



Direct Metal Laser Sintering (DMLS) is an Additive Manufacturing (AM) process whereby fully dense metal parts can be built in a variety of materials directly from 3D Computer Aided Design (CAD) models. Due to the unique method of construction complex part geometry can be built simply and quickly without tooling. Each part is built in a series of horizontal layers from bottom to top by fusing together metal powder with a high power laser beam. To maintain dimensional stability parts are built attached to a metallic platform with a custom support structure that is later removed. Careful design of each part can minimise the size of the support structure and considerably reduces post-processing time. Materials commercially available include Aluminium, Stainless Steel and Alloys of Titanium, Nickel and Cobalt Chrome.

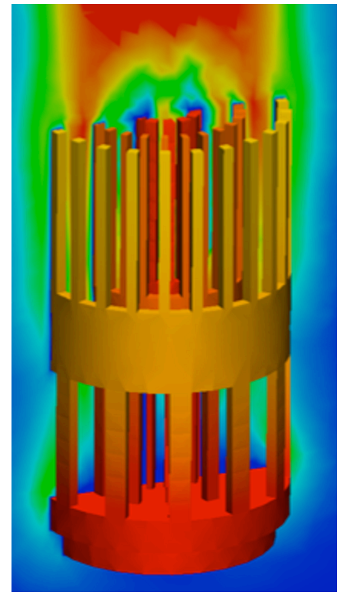
It is well established that keeping the temperature of electronic components below safe temperature limits helps to maintain a long service life and avoids early product failure. The preferred method of achieving this cooling is via the natural convection of buoyancy driven air-flows induced by the electronic heat sources. This method is low cost to implement, simple to maintain and produces zero noise or electro-magnetic interference that can degrade product performance.

However the major limiting factor of natural convection is its capacity to cool products of medium to high power outputs because the air velocities needed to draw heat away from these kind of devices can not be generated through buoyancy forces alone.

Heat energy is most commonly removed from electronic devices by convection through the use of interface components such as heat-sinks or heat spreaders. These are essentially specialist parts with a large surface area; made from a high thermal conductivity material such as aluminium or copper. As the electronic components warm up, heat is quickly conducted away to the extremes of the heat-sink where it can be convected to the air flowing over its surfaces.

The success of natural convection is in large part decided by the ability of the heat-sink to remove heat and transfer it to the surrounding air. Designing effective heat-sinks is a careful balancing act of a number of conflicting factors; these include the need to increase air flow and surface area while reducing pressure losses and manufacturing costs. In order to satisfy these requirements heat-sinks for electronic applications are invariably produced as simple 2D sections extruded, pressed or forged to a repeated length.
If heat-sinks could be manufactured from a high thermal conductivity material with geometries that increase air flow and surface area while reducing manufacturing costs then more electronic products could be cooled by natural convection instead of resorting to more expensive and complex methods.

With this in mind Plunkett Associates as part of the Technology Strategy Board funded SAVINGs project looked at a standard extruded LED heat-sink and investigated how the DMLS process could be utilised to produce an alternative design that was more efficient at removing heat by natural convection. DMLS builds fully dense parts in a range of metals including Aluminium. Due to the way in which parts are built as layers one on top of another, complex geometries can be constructed that would be impossible by other methods. Plunkett Associates designed various different geometries based on the unique characteristics of the DMLS process. Each heat-sink was simulated using Computational Fluid Dynamics (CFD) software to assess the air flow characteristics and associated heat transfer. The five best performing heat-sinks were then built by 3T RPD using DMLS and physically tested to confirm the earlier virtual analysis. In all five cases there was a consistent reduction in the heat source temperature using the DMLS heat-sinks when compared to the standard extruded heat-sink; this result was replicated in all the physical tests.



Electronic devices are becoming more powerful; heat loads are increasing and need to be dissipated as effectively and cleanly as possible. The ability of DMLS to build complex and thermally superior geometries directly in Aluminium means that it has many potential applications in the cooling of electronic devices and heat generating components.

Project TP14/SMP/6/I/BA036D

Project Partners
Plunkett Associates, Crucible Industrial Design, EOS, 3T RPD, Simpleware, Delcam, University of Exeter

Project Website
www.manufacturingthefuture.co.uk

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£1,456,211

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Technology Strategy Board
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Collaborative research and development projects are one of the tools that the Technology Strategy Board uses to drive innovation in the UK. The Technology Strategy Board is a business-led executive non-departmental public body, established by the Government. Its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve the quality of life. It is sponsored by the Department for Business, Innovation and Skills (BIS).

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