LaserCUSING

MAIN IMAGE: M2;
TOP RIGHT: M1;
BOTTOM RIGHT: M3

Additive metal manufacturing processes are undoubtedly taking their rightful place within the spectrum of advanced technologies available to progressive organisations for original and rapid product development. Here the TCT Magazine places the spotlight on LaserCUSING, a laser-melting process that has found its way to the fore in many industrial sectors.

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INTRODUCTION

LaserCUSING was first introduced to the global manufacturing community in 2004 at Euromold by Concept Laser GmbH, the youngest member of the Hofmann Innovation Group AG, based in Lichtenfels, Germany. Simply put, the LaserCUSING process involves the fusion of single-component metallic powders using a laser, which allows components to be built up layer by layer from almost any metallic material, with each layer having a typical thickness of between 20 and 50 μm. The process differs from competitive additive metal processes in two significant ways, namely; employing a different type of laser, together with specially developed and patented exposure strategies and, uniquely, only original, single-component metal materials (ie. no powder mixes) are used. According to Concept Laser the term "CUSING" is made up from the words concept and fusing, describing both the process and result — the complete fusion of metallic powder. There are currently three machine models within the LaserCUSING range: the M1, M2 and M3.

MACHINE TECHNOLOGY

LaserCUSING uses a powder together with an intense infra red fibre laser to completely melt the metal and therefore produce a virtually stress- and deformation-free, fully dense part. The powder material is applied at a pre-determined thickness, and is then fused by the laser according to the CAD data for that specific layer of the part. Laser processing takes place in an atmosphere controlled area within the machine and the systems are capable of producing layer thicknesses of between 20 μm and 80 μm. An important point to stress about this process is the automated powder handling system incorporated within the machines, which eliminates operator contact and increases the speed of the overall process. The finished components come out of the machine at a separate preparation and handling station and have virtually the same characteristics as parts produced by conventional machining methods. Moreover, if required, they can then be machined, welded, hardened or laser eroded.

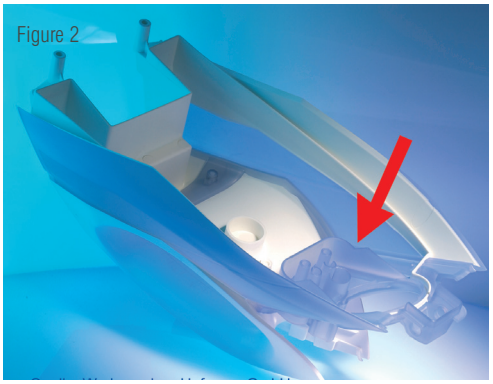
Concept Laser has structured its range of systems to provide easy access to LaserCUSING technology. The entry level M1 system (aimed at die casters, tool makers, contract manufacturers and model makers) produces complex 3D components in a range of hot work steels, inconel and stainless steel utilising a 200W fibre laser within a build envelope of 250 x 250 x 250 mm.

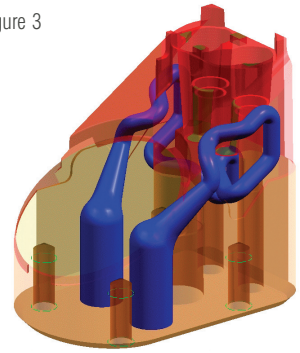
Based upon the proven principals of the M1 system, the M2 LaserCUSING system — the newest machine in the range — produces parts not only in hot work steels, inconel and stainless steel but also in reactive materials, namely aluminium and titanium. Figure 1 illustrates an aluminium part built on the M2 machine. Unlike steel powders, aluminium and titanium alloys react with oxygen, and therefore need to be stored and handled in a controlled atmosphere. The M2 system provides Nitrogen or Argon based inert atmospheres together with a series of sensors and measurement systems that meet all current explosion and fire protection regulations. These features ensure safe and controlled operation at all times — even when running unattended during overnight production. The powder handling concepts within the M2 have been designed and developed to meet the material storage and processing requirements of aluminium and titanium alloy powders, and can be used to store two different materials within the inert atmospheres at any time. The fully-integrated powder handling and extraction

Figure 1.
An aluminium part built on an M2 machine.

Figure 2.
Internal Geometry of the Core Side of the DX9100.

Figure 3.
Image showing conformal cooling ducts of the DX9100.





system of the M2 will return any unused powder to the storage chamber at the end of the production cycle, providing efficient powder recycling and ensuring that the operator has no contact with the powder and that the powder has no contact with air. The M2 LaserCUSING system provides a work envelope of 250 x 250 x 280 mm, and like the M1, produces layers of between 20 μm and 50 μm. The 200 W fibre laser (cw) used in this system has a maximum scanning speed of 7 m/s, which enables production speeds of up to 20 cm^3 per hour depending upon the material being processed.

The modular configuration offered by Concept Laser's M3 Linear system provides the user with three different technologies within a single machine. The M3 Linear operates by using galvo scanning optics together with beam deflection, which is controlled via a combination of galvo mirrors and linear direct drives. This guarantees accuracy in the manufacturing process that remains constant over the large build envelope. Furthermore, the exposure strategy ensures that heat is applied in a random pattern over larger exposure areas in a 'chequer-board' style. This patented laser processing concept makes it possible to produce solid and large volume components with minimal internal stresses.

With the M3 Linear system, there is a choice of a 100 W diode-pumped solid state laser (cw + pulsed), or 100 W/200 W fibre lasers (cw), offering a maximum scanning speed of 7 m/s and a focal diameter of 70-200 μm. For LaserCUSING operations the system has a build envelope of 300 x 350 x 300 mm and can produce layers of between 20 μm and 80 μm. Positioning resolution of the linear motors used in this system is 15 μm. The M3 Linear encompasses all of the benefits of the LaserCUSING process but also provides the flexibility to perform additional laser erosion and marking processes, providing further opportunities to keep the system productive at all times. The 3D erosion module of the M3 incorporates software specifically developed by Concept Laser. A laser measurement sensor linked to the software enables automatic depth control to be achieved during the process. The software calculates the volume of material to be removed and this is then evaporated layer by layer using the laser. Components of 800 x 500 x 400 mm and up to 500 kg in weight can be accommodated within the 3D erosion module. Changing from either the LaserCUSING or laser erosion module to the laser marking module takes a matter of minutes keeping the loss of production time to a minimum. Many different laser marking operations can be performed when using the laser marking module and components up to 450 x 450 mm can be processed. Both plastics and metals can be marked and applications such as day/night marking can also be performed within this system.

APPLICATIONS

The LaserCUSING process was originally pioneered for the mould tool manufacturing industry, however, since its introduction many other sectors have recognised the potential of the technology and implemented it for applications in rapid prototyping and rapid manufacturing as well as inserts for injection moulding tools and pressure die casting.

The benefits of LaserCUSING can be clearly demonstrated within the tool making industry, as the process enables the production of mould tool inserts and components with complex 3D geometries, which are impossible to manufacture by traditional methods in the necessary materials. The ability to produce high resolution features such as conformal cooling channels and thin wall sections, which also have excellent mechanical properties, means that mould tool performance is improved and moulding cycle times reduced. These improvements can mean, for example, that the same productivity could be obtained from a highly efficient 12 cavity tool as would normally be achieved from a less efficient 16 cavity tool. The smaller mould tool may allow for the use of a lower tonnage injection moulding machine and therefore lower hourly running costs and lower costs per component.

One company that has benefited from the LaserCUSING process is Rowenta, which develops and manufactures electrical household appliances to exacting technical standards. The disciplines of research and innovation are a priority for the company, which is always looking for solutions that will offer consumers even more comfortable and energy-efficient products. Rowenta has built up a business relationship spanning almost 40 years with Hofmann Group AG, and it was amongst the first companies to fully realise the benefits of LaserCUSING. The successful result of the co-operation is the Rowenta DX 9100, which is at the forefront of steam iron technology. The mode of operation of the DX9100 is based on 'Intra Steam', a new method that enables ironing with pulsed steam. The concept for this product and subsequent tool manufacture proved to be ideal candidates for production using LaserCUSING generative technology.

LaserCUSING's ability to generate highly complicated 3D forms allowed Rowenta designers to create mould inserts with highly effective cooling ducts that follow the contour of the tool insert (see figures 2 and 3). One benefit of optimally cooled tool inserts is much shorter cycle times. The density of mould inserts produced by this method means that porosity, through which cooling water can escape, is eliminated. For Rowenta this method of mould tool insert production offered sound calculated and qualitative advantages, in particular the contour-optimised cooling increased the productivity of the tool with the mould tool cycle time reduced by 30%; there was drastic reduction of deformation in the injection moulded part through optimum cooling providing better product quality; the semi-finished form contour of the tool insert from the LaserCUSING process reduced the tool insert finishing time; and the process resulted in overall shorter production time for the mould tool inserts.

However, the capabilities of the process are not limited to the production of tool inserts. LaserCUSING can also be used to manufacture high quality production components for use in aerospace, medical and motorsport applications. Indeed, the sale of the first UK-based M2 machine to Airbus UK has recently been announced. The aircraft manufacturer will be using the M2 in its material and process projects as part of the company's research and development activities in Bristol. Moreover, the machine will be on display at the forthcoming TCT exhibition in Coventry, 21–22 October, and will then after be directly shipped to the customer, for installation. Within the United Kingdom and the Republic of Ireland, ES Technology Limited is responsible for the marketing, sales, servicing and support of the full range of Concept Laser products.

W: www.concept-laser.de
W: www.estechnology.co.uk