Changing the future of additive manufacturing

Dr Florian Bechmann, head of development at Concept Laser, reports on trends and increased quality requirements in 3D printing.

The magic word in industrial manufacturing these days is 3D printing. The shift from mould-based component concepts to additive geometric freedom is not just a fad, it's a major trend. The advantages are striking: faster processing times, lower-cost components and a level of design freedom that is so far unheard of. This dynamic market development has spurred two-digit growth rates in the industry.

The main forces behind this momentum include the automotive, medical technology and aerospace industries. These technology drivers demand high standards, not only in terms of quality and choice of materials but also with regard to quantitative aspects such as increased productivity. Customers like these require faster construction times or more parts in a single build chamber.

To meet the needs of the automotive industry, Concept Laser developed the X line 1000R, which currently offers the largest build chamber. It now features a 1000W laser, which represents an important milestone for the process. The laser was developed in close cooperation with laser specialists from the Fraunhofer Institute. The goal was to develop quicker processes that are also more affordable. Very large laser melting systems can be time-saving solutions in developing modern vehicle engines or large-scale aerospace components.

Figure 1. Dr Florian Bechmann: "Customers are currently heavily focused on quality requirements. This requires the right combination of optics, mechanics, control technology and software." Photo courtesy Concept Laser.

Industry demands

The aerospace industry is the source of an increasing amount of innovation that demands high-quality solutions. Many of these involve the use of reactive materials such as titanium or aluminium-based alloys, which must be produced in closed systems to ensure reliability and quality. Customers such as NASA, the German Aerospace Center (DLR), Honeywell, Snecma, Aerojet/Rocketdyne and EADS subsidiary Astrium Space Transportation see the additive process as the next broad-scale step in the evolution of modern production. NASA engineers are even considering using additive manufacturing to produce components on the ISS – in orbit. The advantage of this would be the ability to produce parts in space using CAD data. In the US, we are seeing major investments in capital and human resources, not only in research and instruction but in industry as well. The Europeans can contribute their research and mechanical engineering capabilities mainly in the US and Europe. In Europe, the EU is promoting this process through projects like AMAZE, which focuses on rapidly producing large defect-free

additively-manufactured (AM) metallic components, due to a strong belief in its sustainability and innovative capacity.

Metal laser melting is also revolutionising medical technology: traditional process chains are being completely reconceptualised. Concept Laser's LaserCUSING parts are in demand for implants since their porous surfaces incorporate well into the body while providing the necessary elasticity. One rising application is the affordable and rapid production of dental prosthetics from biocompatible materials. These are highly adaptable, long-lasting dental solutions, as opposed to dental prosthetics that must be handcrafted.

The laser melting process is suitable for retrofitting as well: worn-out turbine parts from power plants or aircraft can be quickly and affordably regenerated. In this hybrid technique, layers of the exact same material can be applied additively to the existing part. In addition to regeneration, new whole parts are also produced for turbine technology applications.

Ramping up R&D

Concept Laser GmbH is an independent company based in Lichtenfels, Germany. Since its founding in 2000, it has been an innovator in the field of laser melting with the patented LaserCUSING technology across many industries. The LaserCUSING process generates components layer by layer using 3D CAD data. The method allows the production of complex component geometries without tools to create parts that are difficult or even impossible to achieve through conventional manufacturing. With the LaserCUSING process, conformal cooling can be used to create tool inserts as well as direct components for the jewellery, medical, dental, automotive and aerospace industries. This applies to prototypes and series parts.

Laser machining systems from Concept Laser process powder materials made from stainless steel, hot work tool steels, cobalt-chromium alloy, nickel-base alloy as well as reactive powder materials such as aluminum and titanium alloys. Precious metals such as gold or silver alloys for jewllery making are also an option.

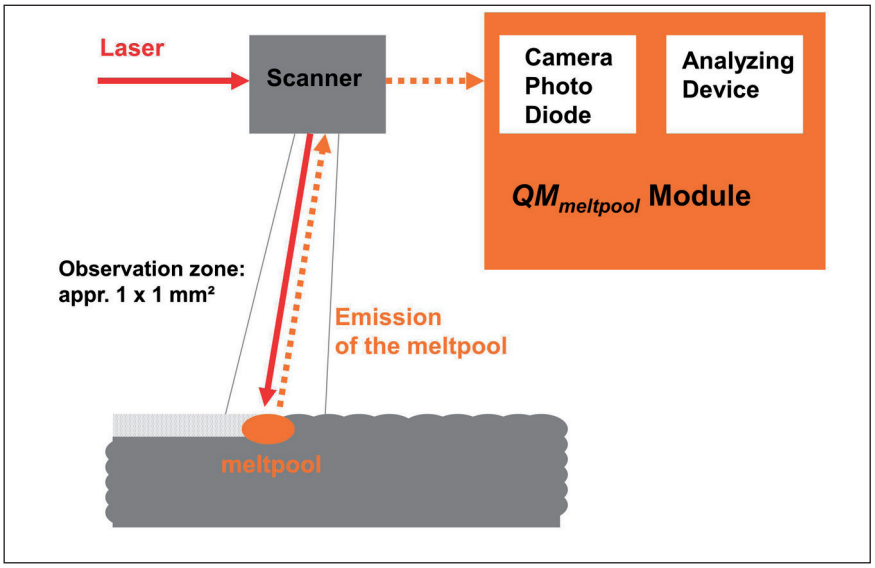

Figure 2. Inline process monitoring with the QMmeltpool QM module: the system uses a camera and photo diode to monitor the process within a very small area of 1x1 mm². The process is then documented. Photo courtesy Concept Laser.

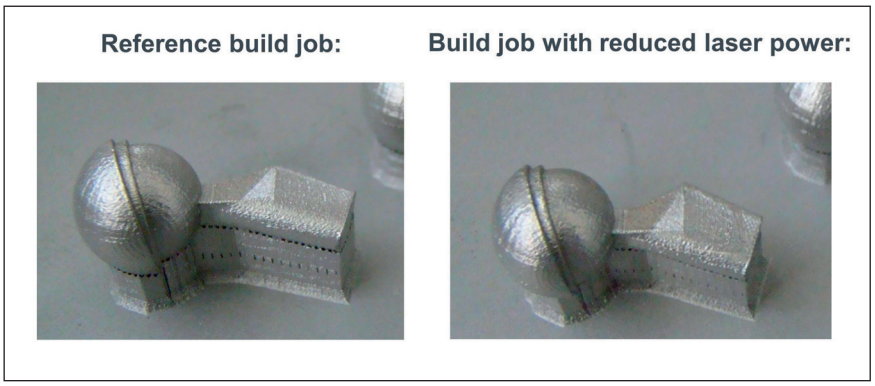

Figure 3. Active quality assurance using QMmeltpool: although the human eye is incapable of detecting defects, QMmeltpool nevertheless identifies deviations in component quality. Photo courtesy Concept Laser.

The LaserCUSING process is used to create mechanically and thermally stable metallic components with high precision. Depending on the application, it can be used with stainless and tool steels, aluminium and titanium alloys, nickel-based superalloys, cobalt-chromium alloys or precious metals such as gold or silver alloys.

With LaserCUSING, finely pulverised metal is fused using a high-energy fibre laser. After cooling, the material solidifies. Component contour is achieved by directing the laser beam with a mirror deflection unit (scanner). Construction takes place layer by layer (with each layer measuring 15-100 microns) by lowering the bottom surface of the construction space, then applying and fusing more powder.

Concept Laser systems stand out due to their stochastic control of the slice segments (also referred to as "islands"), which are processed successively. The patented process significantly reduces tension during the manufacture of very large components.

In an effort to boost its development activities and meet the increased demands of the market, Concept Laser opened a new development centre in late 2013. For design and development engineers from a variety of different industries, metal laser melting offers a fascinating range of solutions. The company's goal is to meet this market trend head-on through innovation. When it comes to complex systems, the right combination of optics, mechanics, control technology, software and powder material is the key.