



Metal-based additive manufacturing technology for professional applications

Additive manufacturing with metal is one of the most complex and impressive production processes in the world. The technology of so-called metallic 3D printing is gaining importance in the industrial field. As a machine manufacturer, SLM Solutions Group AG has a leading position in its industry. The powerful metal-based additive manufacturing technology of the SLM Solutions Group AG is one of the leading 3D printing technologies. The SLM machines are used in many industrial areas and applications.

By Jolanda Heunen



The SLM process is currently used most extensively in the aerospace and medical areas, as well as in the automotive and energy sectors, where numerous fields of application are already being identified. The way of manufacturing metal parts in an additive layer-building process creates new possibilities with regard to geometrical freedom, such as the production of internal cooling channels or undercuts.

Since these geometries are beyond the traditional manufacturing methods, the unprecedented freedom of design flexibility opens up completely new business opportunities. For example, the energy sector benefits from new designs that

reduce component weight and are more cost-efficient with regard to material consumption than the subtractive manufacturing methods. The SLM process for example has brought a new approach for the use of conforming cooling channels installed in components that are used in heat exchangers and turbine generator systems.

This is a freedom of geometry that not only improves on-site system performance, but also allows engineers to design each component for maximum performance regardless of existing manufacturing constraints.

internal cooling channels or undercuts. "The paradigm shift in metal processing continues in companies, since the philosophy of free geometry is increasingly contributing to the integration of additive manufacturing designs into production," Mr. Ritt continues. "In addition, the connection with the classic manufacturing technologies provides further application-optimized solutions."

Gregor Graf, Head of Engineering of Rosswag GmbH continues: "The combination of the two production processes – forging and selective laser melting –

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Combined expertise for industrial manufacturing

SLM Solutions is continuously working to expand its excellence, among other things, in the energy sector. In this context, the company from Northern Germany depends on the cooperation with experienced partners, such as the medium-sized family-owned company Rosswag GmbH, the largest industrial open-die forge in Southern Germany, with the divisions Edelstahl Rosswag and Rosswag Engineering.

Experiences are exchanged to develop engineering services and innovative manufacturing processes for the industrial use of additive manufacturing in combination with many different materials and the classic processing technology of forging.

"The production of additives has enormous potential," says Stefan Ritt, VP-Head of global marketing and communications at SLM Solutions Group AG. "The metal-based additive manufacturing is still a young technology. However, in only fifteen years of research and development, this technology has established itself for applications even in large production environments."

Mr. Ritt continues to tell that this type of manufacturing of metal parts in a powder bed fusion process offers new possibilities to produce geometries that were previously not possible, such as

creates new products which can be produced efficiently through the innovative process chain despite high complexity." The company is addressing the existing constraints of the two manufacturing processes and pursuing the goal of optimizing the process chain, thus increasing the efficiency of manufacturing certain components. "This is done by combining the positive properties of the two manufacturing processes in the respective geometry elements," Mr. Graf states.

100 years of material experience for new solutions in additive manufacturing

The Rosswag Engineering Division builds on the experience of Edelstahl Rosswag and extends its product portfolio with engineering services and innovative manufacturing processes. The starting point was the purchase of the Selective Laser Melting Machine SLM 280 in 2014. For the first time, Rosswag was able to manufacture near-net-shaped, metallic components in addition to forging.

With this step towards additive manufacturing, on the one hand the offered product portfolio was expanded and, on the other, hand the impact of the substitution of forged parts was reduced in the long term. Rosswag pursues the goal to further expand the areas of

additive manufacturing and engineering services. The company supports the customers not only as a service provider, but also as a competent development partner with a holistic, in-house production chain, which offers the customer considerable added value.

The know-how gained over decades in the area of materials science and materials technology serves as the basis for building the future of additive manufacturing. Today, Rosswag has integrated several additive manufacturing systems from SLM Solutions into the production process. Furthermore, starting at the end of the year, Rosswag

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is planning the in-house manufacturing of individual, SLM-suitable metal powders from forging waste and over 400 different materials contained in the 6,000-tonne material warehouse. The company therefore offers quite a unique process chain that extends from the production of the high-quality metal powder, through additive manufacturing, specific heat treatment, CNC rework, and testing of the mechanical and technological properties in the in-house materials laboratory, to comprehensive quality assurance.



Forge-SLM-Hybrid



SLM 280

Forge-SLM-Hybrid

Rosswag Engineering addresses the existing constraints of the two manufacturing processes and aims to optimize the process chain and thus increase the efficiency in the manufacturing of certain components. This is done by combining the positive properties of the two manufacturing processes in the respective geometry elements with each other. From this combination, Rosswag Engineering developed a new process chain, in which the advantages of the forming technology are comple-

mented by the additive manufacturing technology. In this way, a resource and cost-efficient manufacturing of massive components with complex, internal structures can be realized. As Mr. Graf puts it: “The basic idea is to create massive component areas, with a large proportion of material volume, by means of a close-contour open-die forging process. The highly stressable forged blank that is suitable for fiber-orientation is subsequently built additively in the SLM machine in order to supplement the complex structures,

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“The highly stressable forged blank that is suitable for fiber-orientation is built additively in the SLM machine in order to supplement the complex structures, such as the illustrated channels for influencing the boundary layer.”

such as the illustrated channels for influencing the boundary layer. The newly developed and optimized process chain also enables new, constructive freedom with regard to complex geometries and internal structures.”

The current state of the technology

The greatest practical challenge for metal-based additive manufacturing is productivity and automation to be compatible with other conventional manufacturing processes. By means of a turbine blade, the development of the last three years for example, should demonstrate how the SLM process has developed further.

To produce a turbine blade with conforming cooling channels made from nickel-based alloy, two hours and fifteen minutes were required on a medium-sized machine three years ago. Today, the average processing time can be reduced to 35 minutes with advanced technology and four parallel lasers. This is a significant improvement which halves the manufacturing costs per component.

In addition, these machines have developed into increasingly automated machine tools. Today, a powder management system is available that automatically sieves and transports large amounts of metal powder. The unnecessary powder is extracted from the production process, reprocessed for the next production process and re-fed to the machine. This powder recycling loop also allows for autonomous production of larger components without the process being interrupted to be able to be continued only by the operator. Furthermore, it is now possible to remove the entire construction chamber and start a new production process with a second construction chamber in order to reduce the set-up and ‘downtime’ times of the machines. These developments in SLM manufacturing technology are of interest for other

applications in the energy sector. Not only for gas turbine production, but also for renewable energy applications in wind and water systems. In fact, the growing sector of renewable energies is discovering more and more scenarios that now use metal-based additive manufacturing for wind turbines and generators.

A major hurdle for this innovative manufacturing process is the subject of certification and quality control. SLM Solutions has developed machines for metal-based additive production and successfully placed them on the market with quality control systems, automated powder handling and powder control. The industry is developing further in parallel, and tighter qualifications need to be fulfilled for different applications. SLM Solutions will provide more



Impeller with internal channel structures for influencing the boundary layer

advanced quality monitoring modules to meet these requirements.

With these advances in process monitoring, e.g. in-process quality control systems such as laser or melt pool monitoring, the use of metal-based additive manufacturing will be expanded further. The potential for a quick turnaround or remote manufacturing of qualified parts is made possible, which is another big advantage for the energy sector.

Company Profile

SLM Solutions Group AG



SLM Solutions Group AG from Lübeck is a leading provider of metal-based additive manufacturing technology. The shares of the company are traded in the Prime Standard of the Frankfurt Stock Exchange. Since March 21st, 2016, the stock is listed on the TecDAX. The company focuses on the development, assembly and distribution of machines and integrated system solutions in the areas of selective laser melting as well as vacuum and metal casting plants. SLM Solutions currently employs more than 320 people in Germany, the USA, Singapore, Russia, India and China. The products are used worldwide by customers in the aerospace sector, the energy sector, the healthcare sector, and in the automotive sector.

Rosswag GmbH



The medium-sized family-owned company Rosswag GmbH is the largest open-die forging company in Southern Germany with more than 200 employees and is formed of the Edelstahl Rosswag and Rosswag Engineering divisions. For more than 100 years they have been manufacturing highly stressable open-die forging products for power engineering, the aerospace industry, power plant technology, pump construction and the optoelectronic industry. In addition to the two forging and heat treatment divisions, the mechanical processing with more than thirty cutting machines and quality assurance are also important components of Rosswag GmbH. The Rosswag Engineering Division builds on the experience of Edelstahl Rosswag and extends its product portfolio with engineering services and innovative manufacturing processes.