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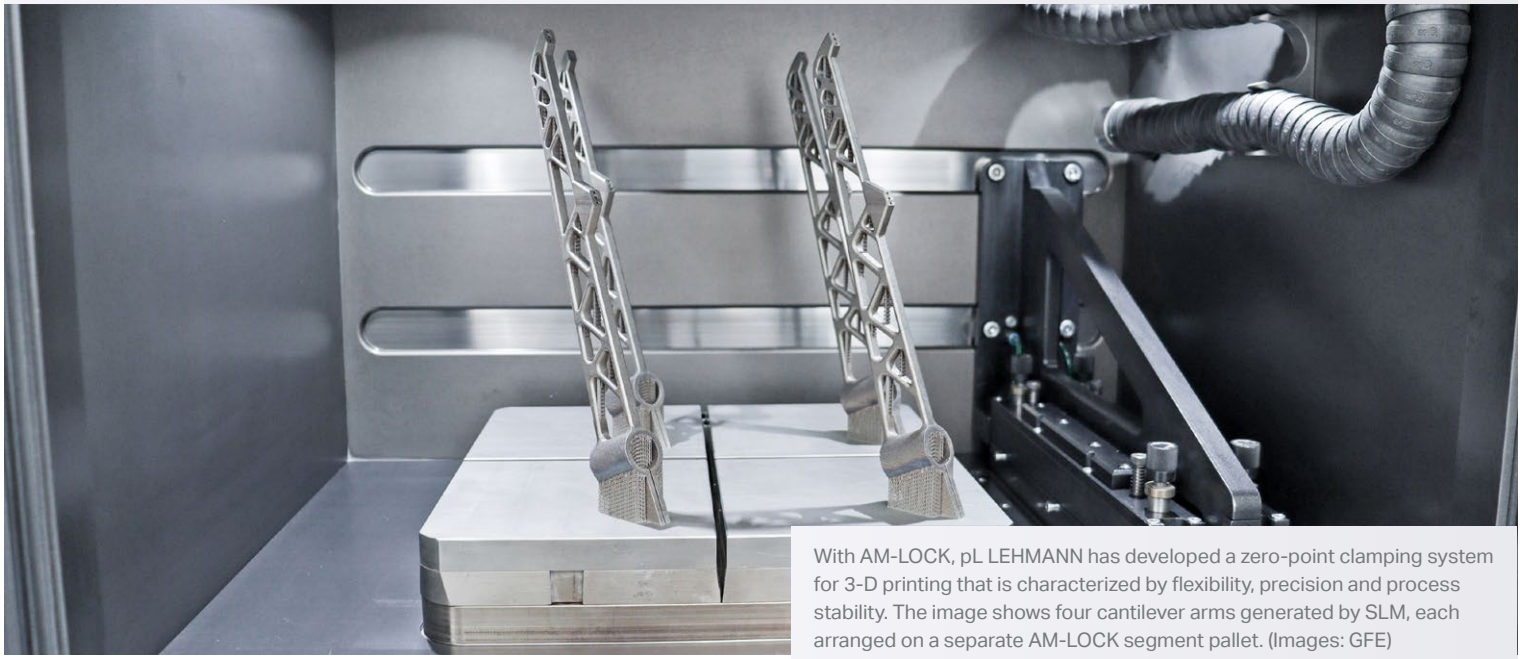
NEWSLETTER

The entire process at a glance

AM-LOCK



With AM-LOCK, pL LEHMANN has developed a zero-point clamping system for 3-D printing that is characterized by flexibility, precision and process stability. The image shows four cantilever arms generated by SLM, each arranged on a separate AM-LOCK segment pallet. (Images: GFE)

The AM-LOCK workpiece clamping system accelerates additive manufacturing, including post-processing

New manufacturing technologies require a suitable environment. With AM-LOCK, pL LEHMANN has developed a zero-point clamping system for additive manufacturing that is proving its strengths at the GFE research facility in Schmalkalden, among others: Applicable throughout the entire process chain, AM-LOCK accelerates the production of 3D-printed parts, reduces effort, non-productive time and costs.

Hardly a day goes by without a success story about the use of additive manufacturing (AM) processes. While plastic components are already being produced by many private individuals at home, metal components require much more expensive machines and much more know-how. However, it is already impossible to imagine the industrial production landscape without metal parts produced additively, especially by selective laser sintering (SLS) and selective laser melting (SLM).

A pioneer in the additive manufacturing of such metal components: GFE - Gesellschaft für Fertigungstechnik und Entwicklung Schmalkalden e.V.. Dr.-Ing. Florian Welzel, Managing Director. explains: «We are an industry-oriented research institution with roots in the traditional tool industry around Schmalkalden. We continuously convert research results into developments with customers and partners, carry out our own preliminary research projects and are thus always at the forefront of development topics.»

AM for tools and equipment construction

The research institute in Thuringia attaches great importance to the use of novel materials and innovative production technology for tools and machine components. In this context, the practice-oriented scientists are working intensively on additive manufacturing of components made of plastic and metal, among other things, with a focus on the latter.

For this purpose, GFE commissioned an SLM system LASERTEC 30 SLM (2nd-generation) from DMG MORI in mid-2018. Its work compartment measures 300 x 300 x 300 mm, and the 600 W laser (minimum focus diameter 50 µm) can produce layer thicknesses between 20 and 100 µm. It is used mainly for research purposes in the field of additive tool development, but also for the production of prototypes, complex individual parts and function-integrated special parts for mechanical and equipment construction, as Dr. Welzel mentions «Our portfolio includes advising customers from the industrial environment on machining and the use of additive manufacturing processes.»

One clamping system for AM and subsequent machining operations

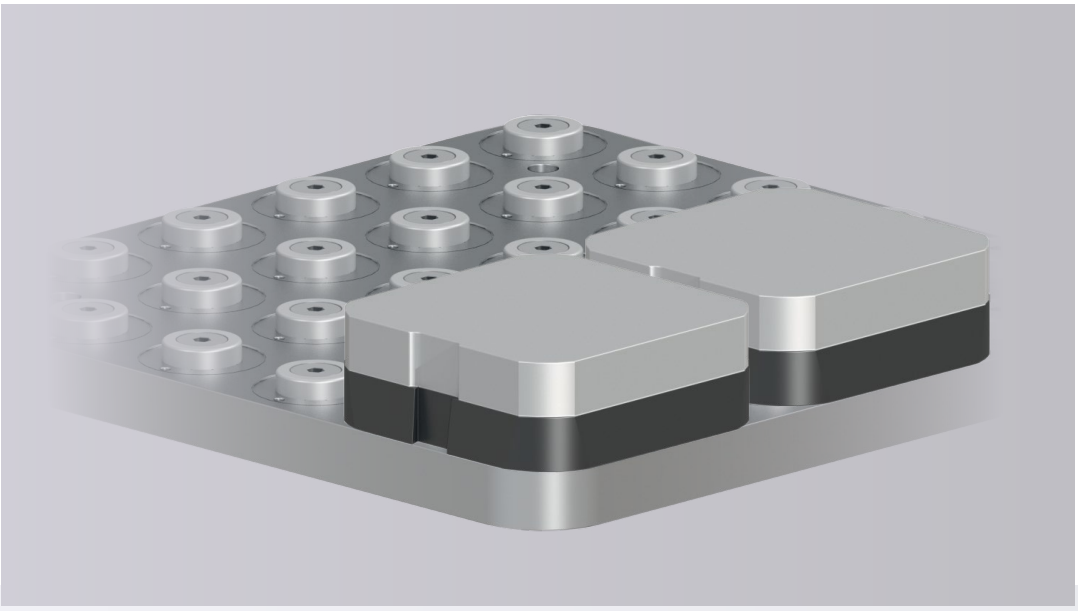
The fact that an industrial-grade system like the LASERTEC 30 SLM alone cannot produce ready-to-use components is in the «nature» of the process. This is because additively generated parts usually have to be machined further before they can be used. For example, support structures must be removed and milling operations performed to ensure that certain surfaces meet precision and surface finish requirements. Sometimes, subsequent heat treating, measurements and coatings are required.

Steffen Lutze, a research assistant responsible for additive manufacturing technology at GFE, therefore asked himself how the processes could be linked in a practicable way and without taking up too much time. At EMO 2019, he discovered the solution: the additive-capable AM-LOCK zero point and positioning system from the Swiss family-owned company pL LEHMANN. Due to its design, it can be used on all common AM machines, withstands temperatures up to 500°C and can be used subsequently unchanged on machining centers etc. without losing the workpiece zero point. «To my knowledge this is unique», says Steffen Lutze. «There are many zero-point clamping systems, but until then I was not aware of any that addressed the requirements of additive manufacturing in this way.»

Patented «Thermo-Lock» positioning and clamping principle

What is special about AM-LOCK? It consists essentially of a grid plate, which is mounted on the work platform of the AM machine, and segment pallets placed on top of it, which are available in various designs and sizes. They always consist of two parts: an easily interchangeable substrate plate made of aluminum, steel or titanium and a basic pallet with a hole grid for zero point clamping on the grid plate.

The most important AM-LOCK element for the AM machine is the Thermo-Lock grid plate. It contains numerous 6-mm-high pins in a 50-mm grid that ensure play-free clamping thanks to different thermal expansion compared to the locating holes. «The Thermo-Lock system is ideally suited for use in an SLM system. The components are insensitive to the metal powder being processed and are virtually maintenance-free,» confirms Steffen Lutze, and points out the special feature of Ther-



The patented «Thermo-Lock» positioning and clamping principle is the primary AM-LOCK element for the AM machine. (Image: pL LEHMANN)

Post-processing on a machining center: The additively manufactured parts are clamped on their separated AM-LOCK segment pallets in the zero-point clamping system.

mo-Lock: «As a result of the process-related preheating of the work platform, this zero-point clamping system virtually clamps itself and can be used without further intervention.»

In actual practice, this means that the segment pallets are unclamped at temperatures below 70°C and clamped on the Thermo-Lock grid plate at temperatures from 80°C to 100°C. The geometric design of the pins also ensures self-centering during thermomechanical clamping, which - according to pL LEHMANN - guarantees a reliable repeat accuracy of ±0.005 mm.

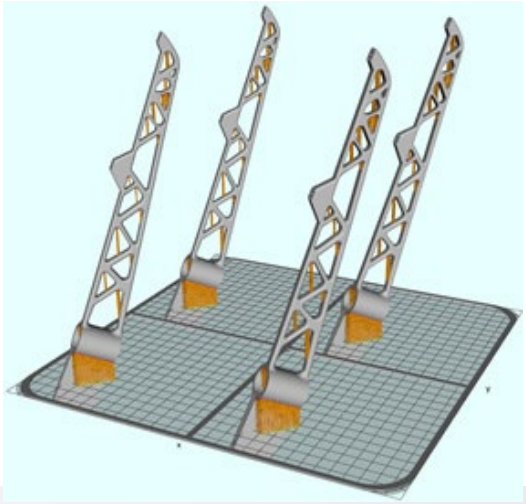
System consisting of grid plate and segment plates

Steffen Lutze considers it particularly beneficial that «we can use segment pallets of different sizes. This allows us to adapt the clamping system to the part size and produce different parts in a single job.» The segmentation facilitates subsequent handling of the AM parts produced, which can thus be fed individually to the respective downstream process required. Compared to a continuous pallet populated with multiple parts, the parts are much more accessible - especially for milling.

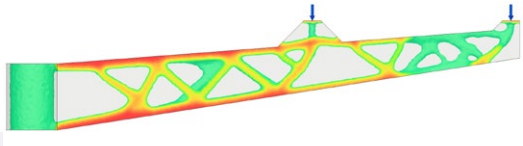
Markus Uhl, a research associate at GFE who also specializes in additive technologies, points out another key strength of the pL LEHMANN clamping system: «The AM-LOCK segment pallets can be clamped on a wide variety of zero point clamping systems using adapter clamping pins without losing the zero point. This simplifies transfer to other machines, such as our machining center, enormously.» The GFE employees place the additively manufactured parts together with the AM-LOCK plate on the existing clamping system of the machining center, finish-machine them and separate the parts from the work platform.

Beneficial thermal response

AM specialist Markus Uhl uses an example to demonstrate how closely research and development work goes hand in hand with practice at GFE. The object is an additively manufactured lightweight cantilever arm for a machine platform. Markus Uhl explains the procedure: «First, we created a rough design and determined the critical load path using FEM simulation while applying the expected load. From here, we proceeded to reverse engineer the part, removing material in non-critical areas - while maintaining additive manufacturability. We were able to reduce the weight of the part further by hollowing it out to a wall thickness of 0.3 mm.»



Preparation of the job in the pre-processing software: The components are placed on the AM-LOCK pallets and given the necessary support structure.



Example of lightweight cantilever arm: The critical load path is determined by applying the expected load with the aid of FEM simulation. The design is then optimized before the STL data is generated and used for additive manufacturing.

After the final part data were exported as an STL file, Uhl prepared the job. That is, he provided the 3-D CAD data of the parts in the pre-processing software with a support structure and placed it on the plates of the zero point clamping system. «Once this preparation is complete, 3-D printing can begin», explains Markus Uhl. «In this example, we created four cantilever arms at the same time, layer by layer in about 36 hours. After unpacking and extracting the non-fused metal powder, we placed the parts individually with their AM-LOCK segment plate on the machining center's zero point clamp. Since we had a defined clamping position, we could start milling immediately.»

Highly capable, business-oriented, experienced

GFE is an industry-oriented research institution that combines many years of practical experience with knowledge from basic and applied research. The 63 employees, most of whom work in the scientific field, deal with tools and technologies for processing sophisticated materials. This essentially involves tools and tool components with integrated sensors and actuators, the structuring of the cutting edge macro- and micro-geometry of precision tools, coating to improve friction or wear properties, the use of novel materials for tools and machine components, and the development of measuring and testing systems. GFE is currently involved in 39 research and development projects.

An essential part of GFE's activities is collaboration with industrial companies, with whom product and technology solutions are developed. The range of services includes combined research and implementation expertise, from preliminary research and pre-competitive development to contract research and technology-oriented services.

The pL LEHMANN company, …

… the Swiss manufacturer of CNC rotary tables and other components for metal machining,, is an experienced machinery manufacturing company whose rotary and tilting axes have proven themselves in production for over 40 years. In addition to these products, which often make three-axis drilling and milling machines into more productive four- or five-axis machining centers, you can also find a variety of workpiece clamping systems in the product line.

Contacts:

Peter Lehmann AG
Bäraustrasse 43
CH-3552 Bärau
Tel. +41 (0)34 409 66 66
Fax +41 (0)34 409 66 00
sales@plehmann.com
www.lehmann-rotary-tables.com

GFE – Gesellschaft für Fertigungstechnik und Entwicklung Schmalkalden e.V.
Näherstiller Str. 10
98574 Schmalkalden
Tel. +49 3683 6900-0
Fax +49 3683 6900-16
info@gfe-net.de
www.gfe-net.de