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November 15, 2021

Press Release

Ceramic at its best.

Additive manufacturing of ceramic components speeds up the production of prototype parts and opens up new possibilities.

Specialist DC motor company maxon is renowned for its drive technology, which has travelled all the way to Mars in various NASA rovers. maxon also has a high-tech department for technical ceramics in Sexau, Germany. Here ceramic components are now also 3D printed and perfected with lasers.

More than 20 years ago, the question was posed “What is even more wear-proof than steel and can be turned into axes and shafts for our planetary gearheads, to make them even more precise and reliable?” Stefan Zilm, Head of Business Development & Quality Engineering at the Competence Center CIM/MIM at maxon, Sexau, knows the answer: Ceramic components produced with ceramic injection moulding, a process that is similar to metal injection moulding.

Today, the company has extensive know-how in the field of technical ceramics. With CIM, components can be series-produced in quantities of several tens of thousands. Yet, in spite of all the experience, and even with the use of state-of-the-art engineering methods such as CAD, finite element calculations and simulations, reality remains the ultimate test that determines whether a new idea is sound, or whether a ceramic part can be produced at all and behaves as planned.

The customary path from idea to real ceramic component is long and costly. An expensive mould is needed to create the green compact to be sintered. Subsequently, it is turned and cut, sintered and sanded in work-intensive processes. Zilm admits: “For a first sample, this is very complicated, it costs a lot of time and money.”

Ceramic out of the printer

But there is another option: using the shortcut offered by 3D printing, which is already well-established for plastic components, and is increasingly also being used for metals. Whereas printing of plastic and metal has been part of industrial production for several years now, ceramic printing is still in the process of venturing from the lab to the factory halls. But the advantages were so tempting that maxon already started pilot tests five years ago, with the aim of getting prototypes of ceramic components to the customers faster – and doing some real pioneering work. Zilm: “With such a printer, the first two to three development loops can be completed a lot easier and faster.”

After intensive market research, maxon decided on a printer from French manufacturer 3DCeram, which was customised to meet the company’s own requirements. “For us, the main selling points were the precision and the rather large printing area of 300 by 300 millimeters,” explains Zilm. The printer is based on the stereolithography method, in which a laser solidifies an emulsion consisting of binder and ceramic powder, and thus constructs a component layer by layer from bottom to top. The layers are between 0.025 and 0.125 millimeters thick. After each layer has been applied, the printer bed moves down one step. This ensures even shrinkage during the solidification, as well as high precision and rendering of very fine details.

A support structure is not required. The special strength of the 3DCeram systems is that it is also possible to create very small parts, with a volume of only 50 cubic millimeters.

Depending on the requirements, ceramic components are usually made of zirconium and aluminium oxides. These are the “bread and butter” materials of the technical ceramics field. Both are available as emulsion for the 3D printer. The debindering and sintering technology corresponds to the CIM procedure, with the result that the green compacts created in the 3D printer can progress through the same manufacturing systems as the series parts. Depending on the complexity of the desired component and the required tolerance level, small series are also possible and a good alternative to ceramic injection moulding (CIM).

According to Zilm, the procedure does have its limits, due to the diameter of the UV laser beam, which determines which minimum wall thicknesses can be produced. The components are cleaned using compressed air and an additive, to remove excess material from the component. Holes with sizes of 0.5 millimeters and smaller cannot be made as perfectly round as in injection moulding, but for prototypes, it usually suffices.

Development partners right from the start

Today, the customer simply sends a file in the standardised STEP format (Standard for the Exchange of Product model data) that has become commonplace in 3D printing, and gets an offer shortly thereafter. Just 10 to 14 days after the order confirmation, the customer can already hold the first prototype parts in their hands. “In the past, that took several weeks or even months, and involved high mould costs,” remembers Zilm.

Ideally, the customer involves maxon right from the start. “We are development partners from the first idea and can thus influence the design to make it as suitable for ceramics as possible,” explains Zilm. Thus it is possible, for example, to combine several components into a single component with optimised functionality. According to Zilm, such optimisations are very important, considering that the price for a kilogram of the commodities needed for ceramic is around ten times that of steel. “We have to justify this by providing significantly better functionality, for instance through wear resistance, temperature stability or not requiring lubricants.”

But the limits of additive manufacturing have not yet been reached. Andreas Philipp, Head of the Competence Center CIM/MIM, is certain: "We have to start thinking in 3D and not in the classical way as before." Then completely new possibilities will open up, so that 3D printing could be a real alternative to the established processes.

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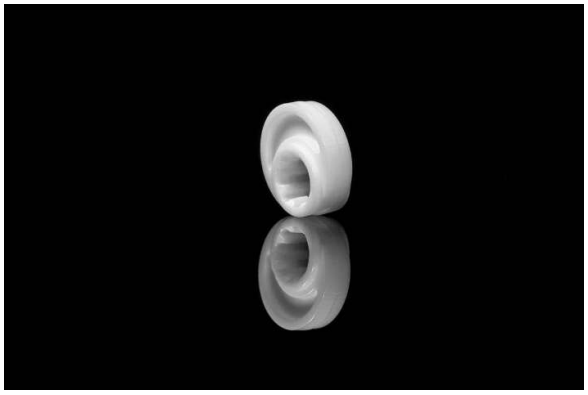
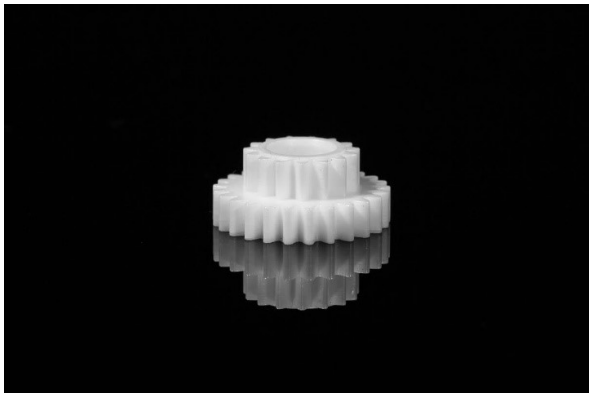
Length of this update: 943 words

The press release is available on the internet at: www.maxongroup.net.au



Ceramic 3d © maxon Group



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The Swiss specialist for quality drives

maxon is a developer and manufacturer of brushed and brushless DC motors. as well as gearheads, encoders, controllers, and entire mechatronic systems. maxon drives are used wherever the requirements are particularly high: in NASA's Mars rovers, in surgical power tools, in humanoid robots and in precision industrial applications, for example. To maintain its leadership in this demanding market, the company invests a considerable share of its annual revenue in research and development. Worldwide, maxon has more than 3000 employees at nine production sites and is represented by sales companies in more than 30 countries.