INTERVIEW

When thin layers are sufficient for heavy mechanical engineering

Researchers at the Fraunhofer Institute for Laser Technology ILT are working with ADMOS Gleitlager GmbH to develop a promising alternative to solid rolling bearings for wind turbines. They aim to use extreme high-speed laser material deposition EHLA to produce low-cost and low-maintenance sliding bearings. This resource-saving and economical process can reduce weight and costs by up to 20 to 30 percent. The research project is being funded by the German Federal Ministry of Education and Research (BMBF) and offers a promising solution to help expand wind power quickly.

A new application for extreme high-speed laser material deposition EHLA is the focus of a BMBF research project. On board are the Fraunhofer Institute for Laser Technology ILT from Aachen and ADMOS Gleitlager GmbH from Berlin. Together they are investigating whether an EHLA coating just under 900 micrometers thin can provide sliding bearings with a sliding surface just as good as the cast coating that is up to seven times thicker – with a comparably low coefficient of friction. Jörg Hosemann from ADMOS and former ILT scientist Matthias Brucki explain how they plan to conquer the wind power sector and other industries with laser energy.

Mr. Hosemann, how did ADMOS get into laser material deposition?

Jörg Hosemann, Managing Director of ADMOS Gleitlager GmbH, Berlin: As a manufacturer of industrial bearings, we are constantly concerned with coatings. We cast sliding bearings ourselves, but have been looking for an alternative for a long time. In 2016, we therefore invested in our own laser system for laser material deposition – LMD for short – which we designed ourselves. This LMD system is used to replace the sliding bearing layers, which are typically 2.5 to 3.5 mm thick. We use it to apply layers 1.0 to 1.5 mm thick on the base body in multiple layers with 5 to 6 kW of laser power. But that's exactly where we said to ourselves one day: "That's not bad. But can't we use even thinner layers?"

What has been your customers' experience with laser material deposition?

Hosemann: Very good. Since 2017, 10,000 laser-welded sliding bearings have been in use and no damage has occurred to them so far.

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Now, EHLA is probably not intended to completely replace their LMD process: What division of labor is conceivable for you?

Hosemann: EHLA is particularly suitable for temperature-sensitive, rotationally symmetrical components with very thin running layers. LMD is also suitable for rapidly applying thicker layers to non-rotationally symmetrical components such as slide rails, tracks and segments.

One of your specialties is self-developed coatings such as the higher-strength white metal ADMIRO56. Do you also rely on customized powder for metallic 3D printing?

Hosemann: That is true. Many years of application knowledge in the field of materials development is one of our strengths. Laser material deposition now also permits other, new material combinations such as tin alloys with significantly higher copper content or copper alloys with embedded solid lubricants, which previously could not be processed by casting or could only be processed with difficulty. An increasing part of our work now involves optimizing the materials for the process.

Mr. Brucki, how did the Fraunhofer ILT come into the picture?

Matthias Brucki, at the time of the project Group Leader for Process and Application Development LMD at Fraunhofer ILT: We got together in 2020 through the KMU-Innovativ ERBE research project, with which the German Federal Ministry of Education and Research (BMBF) primarily supports small and medium-sized enterprises. In concrete terms, the project aims to replace the current melt casting process as far as possible. What mainly speaks in favor of this is the high resource and energy efficiency. Compared to melt casting with a maximum layer thickness of 3.5 mm, we can already manage with a single-layer coating of around 500 µm with EHLA. ILT project manager Stefanie Linnenbrink is already testing the new process chain with ADMOS, a chain that requires lower material and energy input. It is time to stop design departments from feeling they need to use high layer thicknesses. The time to do this is very favorable right now – with the enormously rising prices for energy and materials.

How much energy do you save when using lasers?

Hosemann: Around 90 percent. There is no getting around the laser process any more in order to get away from energy-intensive manufacturing processes. This is also underscored by the fact that half of the crucibles in our foundry operate with gas.

With EHLA, you also have your sights set on sliding bearings for wind turbines: But rolling bearings still dominate here. Do you now see an opportunity to make the switch thanks to laser coating?

Hosemann: Yes. We have been fine-tuning a sliding bearing solution with a well-known German manufacturer of wind turbine drives since 2017. But I can understand the skepticism, because the technical risk is naturally high. However, a paradigm shift is on the horizon: We have finally managed to get wind turbines running with our sliding bearings. What speaks in their favor is that they enable enormous increases in performance. For this reason, I am sure that this solution will become established. But we also know that laser technology for this application is not yet 100 percent ready for series production.

In 2004, sliding bearings were used for the first time in large 5-MW wind turbines. However, this drive technology was not able to prevail over rolling bearings. At that time, we were still told that sliding bearings were only suitable for the preliminary stage of the gearbox, and that we would only use rolling bearings in the main stage. What do you hear from the wind power industry today?

Hosemann: Customers are increasingly asking me whether all wind turbine gearboxes worldwide can also be designed completely with sliding bearings. And I can unequivocally answer in the affirmative.
Brucki: I see it the same way. In my search for applications for laser material deposition, I came across the topic of sliding bearings relatively early on at Fraunhofer ILT. With the right laser coating, it not only enables increased performance, but also saves weight because the heavy and larger rolling bearing is eliminated in comparison. Calculations suggest that weight and costs can be reduced by 20 to 30 percent. With these arguments I approached the sliding bearing industry and finally met Jörg Hosemann from ADMOS Gleitlager. At some point, the discussions with him also led to wind power.

What does the change from rolling to sliding bearings mean for the design?

Hosemann: It is certainly possible to design even a complete three-stage wind turbine gearbox entirely with sliding bearings. But this means that the design, coating, oil supply and materials all have to be optimized, among other things. In the first step, for example, it is advisable to use materials which have already proven themselves in the field. In the second step, the material must then be adapted to the individual gear stages.

You were talking about weight savings and performance improvements?

Hosemann: When we switch over to the sliding bearing, for example, 17 to 18 rolling bearings with a bore diameter of 200 to 400 mm are eliminated in a three-stage gear unit. These are saved completely because the gearwheel runs directly on the coated shaft, which has to be manufactured anyway. This not only saves weight and installation space, but also increases performance. This is because I can install a significantly more powerful gear in the same nacelle, which is no heavier than the drive element used previously. That means I don't need as many new wind turbines either.

Mr. Brucki, what concrete results did the joint trials with ADMOS produce?

Brucki: For multilayer coating, the EHLA layer thickness was only 856 µm. The extremely low heat impact and high material efficiency also speak in favor of the process. 95 percent of the powder used goes directly into the coating. And material efficiency is not limited to the material used in the manufacturing process.
Hosemann: By the way, that speaks in favor of both laser coating processes. In contrast to fused casting with its high coating thickness, LMD and EHLA also reduce the amount of mechanical post-processing required. With EHLA, however, Mr. Brucki convinced us with a particularly near-net-shape coating surface and roughnesses of just a few µm.

So the two laser processes coat close to the final contour, meaning that the effort for subsequent machining is minimal?

Hosemann: Yes, and that is precisely the goal for series production. We want to reduce dimensions and work steps. And we are now in the prototype stage on the way to pilot production. Some of the laser technology still has to be made ready for series production.

How much material do you save?

Hosemann: Around 70 percent, because we coat close to the final contour. In casting, we have to double and sometimes even triple the amount of raw materials due to the process.

What else generally speaks for the use of lasers in coating?

Hosemann: A foundry can only be automated to a certain extent. The core is the expertise of the foundryman, on whom you are totally dependent. With the laser process, there is a program that you break in. Once the parameters have been entered, the process works with 100 percent repeatability if it is properly monitored and automated.

What applications are there for laser-coated sliding bearings outside of wind power?

Hosemann: Vehicle technology, definitely. I'm thinking, for example, of hydrogen combustion, which requires new bearing concepts because completely different pressures and temperatures prevail. In addition, there are many inquiries about newly emerging industrial applications.

Mr. Brucki, up to now, meter-long off-shore cylinders have been coated with EHLA. What fascinates you about this new project?

Brucki: It is a matter close to my heart that we can now also make a positive contribution to wind power with laser technology. The trend is clear: The critical component size that makes coating worthwhile is continuously decreasing. Because the coating process is becoming less expensive. The productivity of the EHLA process is increasing, while the acquisition costs for laser equipment are decreasing. If we concentrate the high-quality material only on the area of the component where it is needed, coating creates a competitive advantage.

Mr. Hosemann, Mr. Brucki, how do you assess the future of laser technology for sliding bearings?

Both: There are an unimaginable number of applications for laser-coated sliding bearings. We do not see any limitations at the present time. However, for each new application we have to put the material selection to the test and adapt the laser process to the requirements. Based on years of experience in both fields, we look forward to a promising future together.

Interview: Dipl.-Ing. Nikolaus Fecht on behalf of Fraunhofer ILT

ADMOS Gleitlager GmbH, Berlin
Over a century of know-how in the field of sliding bearing development characterizes the company, which was founded in 1909 and today employs 75 people. It develops and manufactures composite sliding bearings for special applications. The Berlin-based company benefits from the fact that it also masters the coating processes for the production of composite materials and carries them out itself. This includes a laser material deposition process developed in 2016 that has already proven itself many times over in the efficient and environmentally friendly production of composite materials. ADMOS sliding bearings are used as customer-oriented solutions in large gearboxes, compressors and turbines, among other applications.
www.admos-gleitlager.de

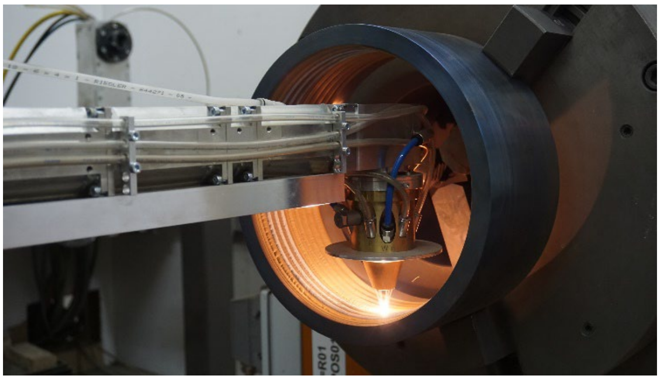

Image 1:
Production of a sliding bearing in the inner radius by machining lance for laser material deposition (LMD) at ADMOS.
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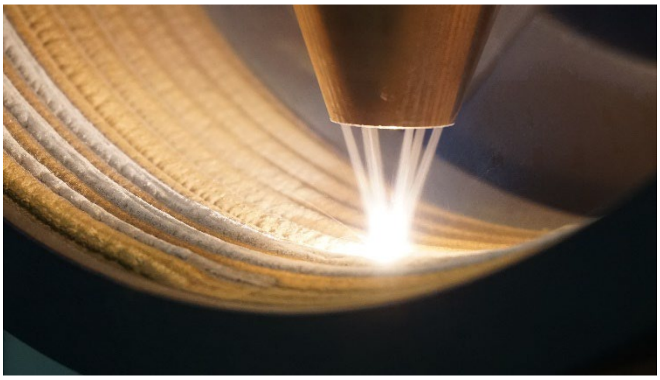

Image 2:
Laser material depositon (LMD) at ADMOS.
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Image 3:
Exchanging rolling bearings for sliding bearings saves weight and installation space. This means, for example, that a significantly more powerful gearbox can be installed in the same nacelle.
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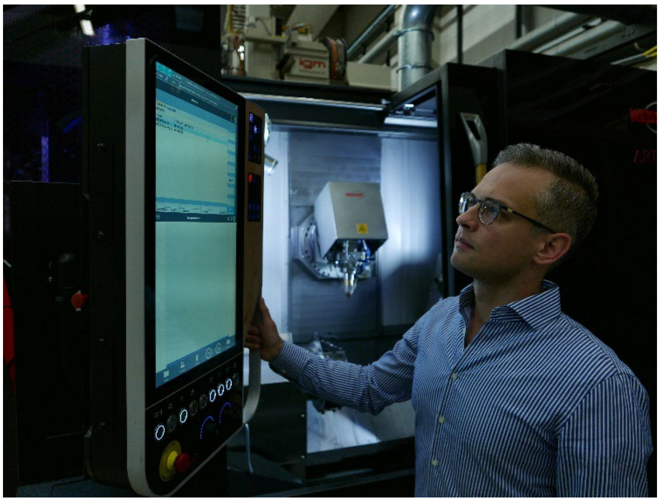

Image 4:
Matthias Brucki at the Artery turning machine from Weisser with integrated processing head for extreme high-speed laser material deposition (EHLA) at Fraunhofer ILT.
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