Views

Lasers in Green Production: The best is yet to come

When the first laser was built in 1960, it was described as 'a solution looking for a problem.' Today, lasers not only solve many tasks in production but even offer entirely new solutions that help save energy, material, and finally money. Andreas Thoss spoke about those opportunities with Klaus Löffler, managing director sales and service at TRUMPF Laser- und Systemtechnik GmbH, one of the largest providers of laser material processing technology.

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Klaus Löffler is member of the managing board and head of international sales at TRUMPF Laser- und Systemtechnik GmbH in Ditzingen, Germany. He graduated in mechanical engineering with focus on laser technology at the University of Stuttgart and started as development engineer for CO2 lasers at TRUMPF in 1991. From 1995 until 2002, he worked for TRUMPF Inc. Lasertechnology Center Plymouth, USA, and established the Service and Sales departments there. Afterwards, he was from 2002 until 2006 head of the department joining technology at Volkswagen, before becoming head of international sales at TRUMPF in 2006.

AOT: Lasers have always had a positive image of being a cutting-edge enabling technology. In recent years, they have even been adopted by several major industries such as the automotive industry, but what essential progress have lasers brought to the production floor?

Klaus Löffler: The laser as a photonic technology has a number of advantages for production processes. High energy in a small spot basically allows faster processing with little distortion. This goes along with the trend to reduce or to optimize the resources that we put into products. The thinner the material gets, the smaller the product can be made. If we now consider the fact that everything is getting smaller and more compact, then, the laser is a much better tool than any other cutting or welding tool that's available right now. This allows the industry to go in the direction of energy and resource efficiency, to use less material, to reduce friction, and to optimize technical products and, therefore, take them closer to their physical limits.

AOT: Would you say that lasers make a 'green switch' possible for the machining industry, for the tooling industries?

Klaus Löffler: Yes, but the impact is, to a certain extent a small one when it comes to machine tools side-, or the production technology. There is a much higher impact on end products like, for example, the car industry and other industries; so let's go to the car industry since everybody knows what cars look like.

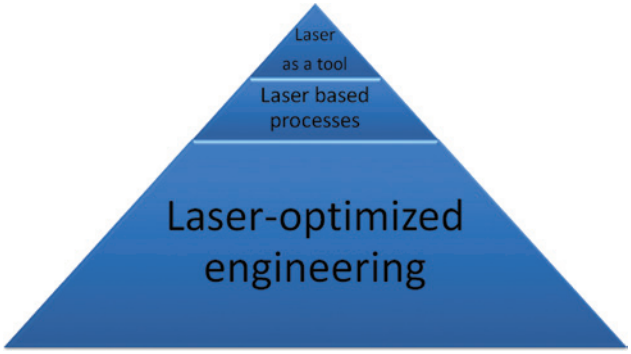
One example is laser-based hole drilling for injection valves. This technology helps to optimize gasoline consumption. Reduce it by a certain percentage and you end up with a consumption reduction of several hundred or thousand liters or gallons for one car. Now take this reduction and multiply it by the total number of cars on the road and then you see that the total reduction is far greater.

That's a huge impact if we look at the laser as a tool. Compared to the energy savings in the drilling process alone, we only save $1 per day with the laser.

And this is exactly what came up this morning in a phone call I had with one of the leading automotive companies. They told me, 'We're not interested in talking about your laser anymore or getting the price down or anything else. We have to make sure that the laser light is used more efficiently.'

AOT: This raises the question of laser-based processes...

Klaus Löffler: Laser welding is a very popular laser application. The processes are certainly very advanced but not fully understood yet. So I see huge potential for further improvements.



Energy Pyramid: Laser technology in production enables various forms of savings. The laser as a tool (top) allows for energy savings when replacing other technologies. Laser-based processes (middle) often allow for saving time, energy, and material. But the biggest saving potential lies in laser-optimized engineering (bottom). Here, the laser enables entirely new design concepts that use far less energy and materials.

Let me give you an example: Just recently, we combined the benefits of laser welding with the advantages of electron beam welding. Electron beam welding gives excellent weld quality but needs a high vacuum, so this is seen as a disadvantage, which renders it unsuitable for mass manufacturing processes. With laser welding, on the other hand, there is still the challenge on weld quality with difficult to weld materials, in particular spatter, when you use short wavelengths. This was a starting point for us to talk to some experts to see if there was a chance to use ideas from both worlds. After some experiments, it turned out that we can achieve superior weld quality with laser welding in a low vacuum.

To our surprise, the welding process was already perfect at 10–100 mbar, enabling a 20% greater welding penetration depth. We got a perfect welding seam with no kerfs and no more spatter. There was no longer any loss of material and, most importantly, the weld seam was excellent, meaning that we no longer needed to clean the seam.

AOT: That's very impressive! What's your plan with this?

Klaus Löffler: We've just started a research project to find out more about it and have immediately received government funding. In the long term, we envisage a laser with just a vacuum bell, making a small vacuum in less than a second. With a small investment, I would get a superior welding process while saving energy, material, and time.

A 4-kW laser would probably do what a 6-kW laser has done so far. That is a saving in investment and in running costs as well. This shows us again that we have to find ways for a more efficient use of laser light.

AOT: The new welding technology sounds very promising. But when you lean back, where do you expect the biggest savings with laser technology?

Klaus Löffler: In car manufacturing, welding is still done on overlapping steel sheets. Light penetrates the first sheet, and then the second. Only a small fraction in the center helps to create a welding seam. There, most of the precious laser light is wasted. That's where we need more efficiency.

This is where Green Photonics starts. Today, we have so many different wavelengths available. The task is now to develop more efficient processes. Efficient processes generate bigger savings than the laser, itself.

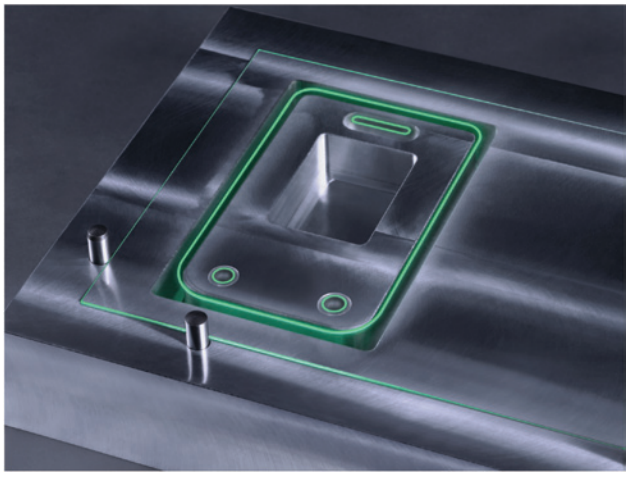
Nevertheless, the greatest savings potential lies in the end product. If the product is designed for laser manufacturing processes, be it conventional or even new processes, such as laser additive manufacturing – then the savings are biggest. Laser additive manufacturing creates entire components from metal powder, usually in a weight-optimized shape. This is very energy efficient, and there is almost no wasted material. Laser additive manufacturing has now been introduced in aircraft construction, where weight savings convert directly into fuel savings or higher cargo capacities. Here, laser-optimized engineering shows its full potential.

AOT: Now, let's turn to applications. What do you think are the current and future fields for massive laser technology applications?

Klaus Löffler: In terms of numbers, the first is definitely marking. This coincides with the mega trends towards the individualization and the traceability of products. There are hundreds and thousands of lasers out there, but most people don't notice them anymore because they're just a part of a manufacturing system.

Then we still have this big market for cutting, cutting different materials, but mainly cutting metals. This will also continue. Tube cutting is booming, and we have a lot of industrial welding.

The coming applications, which are definitely new, are more demanding applications in the semiconductor industry. More drilling, via drilling, more than we have seen before. We are deeply involved with EUV technology (Extreme Ultra-Violet is a next-generation lithography technology with feature size down to about 10 nm).



Cover screens on smartphones are extremely hard and thin. Cutting them with ultrashort pulse lasers successfully prevents microscopic cracks on the edges – leading to longer service life.

Another new area is energy storage. There are many laser applications for all different kinds of batteries. Another application is surface modification. With laser additive manufacturing, we can produce entire materials, optimize surfaces, or build up materials. We can enhance materials with the laser. This will be another trend, but it will still be a few years before it grows into a significant part of the industrial laser usage.

AOT: An extremely hot topic is carbon fiber-reinforced plastics [CFRPs]. Do you think that the laser will play a role in actually getting it from a manual process to a really automated process in car manufacturing?

Klaus Löffler: It can help, but it will not reduce the cycle times that we see right now. We invested a lot of time and capacity in carbon fiber processing. We think that we have all the processes that are necessary: cutting, marking, and drilling and engraving processes. It's all production ready with the laser so that you don't need an ultrasonic knife or water jets that are really nasty in production.

But I think this is just one part of making it really cost effective and competitive with aluminum or other materials. There is more that we have to put in there, more into the process line itself. The molding process is still too slow, and the laser cannot enhance it; but what we can do, if we switch to other additives, is perhaps to weld the carbon fiber later on.

AOT: Welding CFRP... You mean with similar materials or with different materials?

Klaus Löffler: With similar *and* with different materials, like joining it to metal. That's critical at this point of time. You could also laser weld carbon fiber materials with carbon fiber materials. Adhesives or mechanical joining is the only way right now. With the cost differences between steel, aluminum, and carbon fiber, there is still a factor in-between; there is the problem of recycling these materials.

BMW is one good example here. It has just gone ahead and done it, straight into production. That's the first time the industry has gathered experience in a kind of mass production setting. Now, we can start optimizing the whole process along the line to make it cost effective in the future.

So far, everybody has just been dealing with CFRP in a lab environment, where we cannot really achieve an industrial manufacturing scale.

AOT: Still, it is very interesting and promising. Another promising application was photovoltaics. Now, we see a large consolidation in the photovoltaics market. Do you still see photovoltaics as a potential mass market for laser systems?

Klaus Löffler: Yes, we see it as a potential market. We saw it as the most promising market a few years ago, but this has all turned around. Now, most of the manufacturing has moved to Asia. Even though the main R&D for the next generation for photovoltaics is actually located in Freiburg (nearby in Germany, still, the efficiency has to be increased).

That means we need more accurate processing and a lot of laser processes for the next generation of photovoltaic-integrated modules. But it is still a matter of whether the demand can be stimulated by subsidies and whether the efficiency can be increased so much that people can just buy it without subsidies because it's competitive with the electricity we can get out of the grid. We need it and it's just a matter of time. And lasers are definitely an enabling factor for higher efficiency.

AOT: Finally, as a company, what is your position regarding Green Photonics?

Klaus Löffler: As a company, we invest a lot into methods of using the laser light on material most effectively. We have developed a way in which we just modify an optics, and we can increase the welding speed or steps by 20%. This is what we all have to invest in right now, and we have to invest in the knowledge based in the industry

revolving around the laser. The reason that Germany is one of the leading countries is because we have been investing in research concerning a correct use of the laser for a long time now. It always comes back to the design of the end product. A designer has to design an end product, and that's where the foundation is laid, whether the lasers are used or not and whether it becomes a green product or not.

AOT: Thank you very much for the interview.

Klaus Löffler was interviewed by Andreas Thoss, th@thoss-media.com