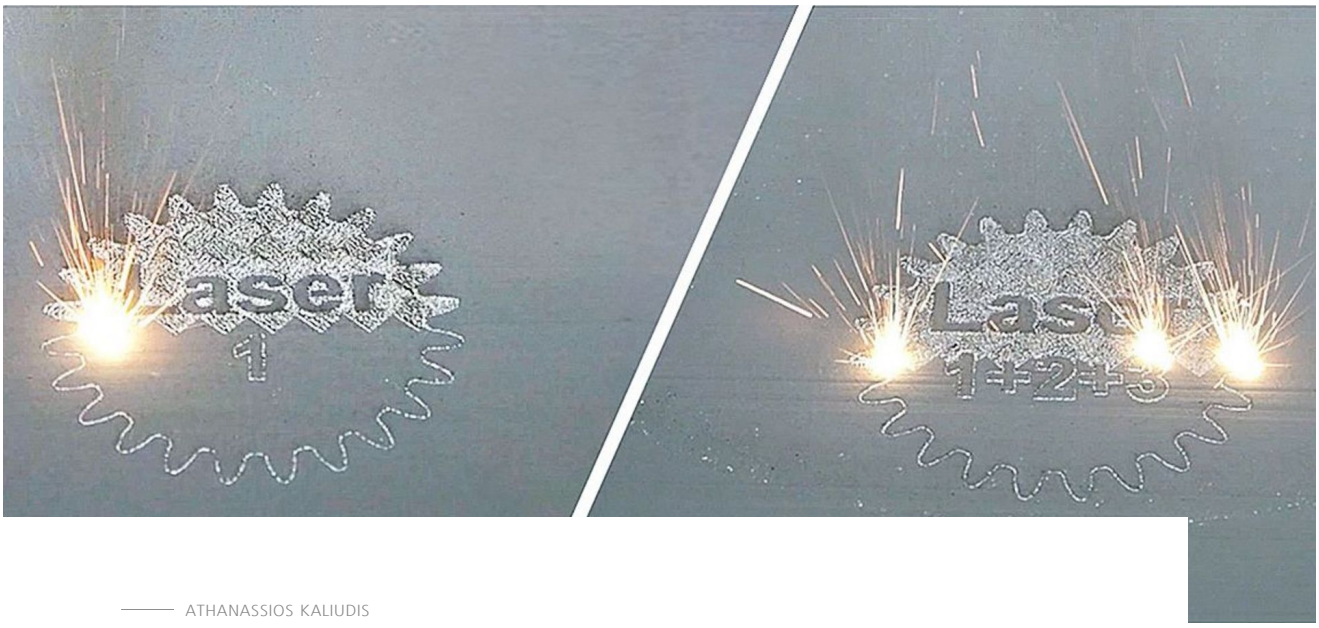

ATHANASSIOS KALIUDIS

Light Designers

Exposure strategies are one of the keys to achieving even higher productivity in the manufacturing of 3D-printed parts. This article explains how they work.

Tucked away behind the glass facade of TRUMPF headquarters is a brainstorming room used by an additive manufacturing team. This is where they craft strategies and opportunities to make this promising technology more productive and to extend its appeal to a broader user base. Although additive manufacturing is a hot topic and a popular choice for small-batch production and prototyping, a lot must happen before additive manufacturing can compete with more established metal-processing technologies in small and medium-sized enterprises. The process must become more robust, reproducible and economical.
TRUMPF experts are pursuing multiple avenues to significantly reduce the cost per part. One example is a multi-machine strategy that takes advantage of external industrial handling of powders and parts to better utilize machine capacity and boost productivity. Semi-automated solutions also reduce per-part costs.

Structured analysis

But the most striking improvements come from choosing the right exposure strategy. Damien Buchbinder and Florian Krist, both additive manufacturing product managers at TRUMPF, have investigated a wide range of exposure strategies – categorized by industries, applications, part geometry, material and costs. They analyzed every conceivable option to determine the potential, anticipated costs, benefit for individual applications and technical feasibility in each case. "We were fortunate that TRUMPF has such solid expertise in lasers and optics. As well as the simulations we ran ourselves, we were also able to have experts verify our analyses thanks to numerous, ongoing joint-development projects," says Krist.

Thick roller – or fine brush?

The main pillars of the exposure strategy are the optics and beam source. These two factors not only determine the speed of the process, but also have a significant impact on part quality. The challenge lies in striking the right balance between the key parameters of laser power, power density distribution, beam diameter, number of beams, and the scan line spacing between the beams. And that, says Damien Buchbinder, is where the dilemma begins: "Imagine that you need to paint something and have to choose between a paint roller and a fine brush. The roller lets you apply a lot of paint in one go, but it's not very accurate. The fine brush is more precise, but that means the painting job will take longer." In additive manufacturing, the paint is laser power.

TruPrint 5000

TRUMPF presented a demonstrator of its TruPrint 5000 at formnext 2016. While it features the same scanner-controlled fiber laser technology used in all TRUMPF's 3D printers, this new machine offers not just one laser. It is instead equipped with three 500-watt laser beam sources, making it the company's first multi-laser system for additive manufacturing. What is truly special about this innovation? The three lasers are mounted in a specially designed TRUMPF optics system and arranged in a way that allows them to either expose multiple parts in the construction chamber at the same time or to work together on a single part up to three times faster. The laser power has been configured to facilitate processing of many materials while maximizing productivity. This flexibility also extends to the beam diameter, which users can set anywhere from 100 to 500 µm. This ensures outstanding processing quality and allows users to process materials that require less intense laser light if spatter is to be kept to a minimum.

The ratio between the tool – that is, the roller or brush – and the quantity of paint applied represents the power density distribution. Whatever the size of the tool – in this case a laser beam – it must always provide sufficient power density to melt the powder. "How do we meet this requirement? That's where the exposure strategy comes in: it addresses the need for different melt energies and laser intensities to process different materials. The level of detail and processing speed required in each case determines the laser power, laser density and brilliance," says Buchbinder.

Today the best

When you compare the results of the analyses conducted by Buchbinder and Krist, the most striking finding is that no universally valid formula exists yet for calculating the optimum approach for every material, geometry and industry. Not everything that would be perfect in theory can be implemented using today's technologies. What's more, some things that are feasible may not make sense from a cost-benefit perspective. But enough about theory. The TRUMPF TruPrint 5000 demonstrator represents the best solution based on the current state of the art. "We opted to configure this machine with a one-size-fits-all exposure strategy. It's the perfect choice for many different applications," Buchbinder explains. "Nevertheless, additive manufacturing is all about staying on top of the latest developments. Lasers and optics are constantly evolving, so new opportunities in exposure strategies are likewise emerging all the time."

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