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# Cutting waste, not corners – how advanced lasers are shaping eco-friendly manufacturing

A new generation of lasers using ultrashort bursts of light is showing great potential for the sustainable manufacturing of precision parts.

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German mechanical engineer and research manager Martin Osbild is a fan of avoiding waste. At home, he would far sooner repair than replace broken household items – from washing machines to food blenders and bicycles. At work, the same environmental principles are high on his agenda.

Osbild is leading a team of researchers at the Fraunhofer Institute for Laser Technology (Fraunhofer ILT) in Aachen, Germany, who are looking at how improvements in laser technology could help cut down on waste and enhance environmental sustainability in manufacturing.

Their work is part of a four-year EU-funded research collaboration called METAMORPHA that will conclude in August 2026.

## Precision production

The main focus is on laser micromachining – the extremely high-precision shaping and processing of metals and other materials needed in areas such as electronics, aerospace and medical applications.

This work is becoming increasingly important amid a growing demand for miniature components. Today's production lines rely on micromachining in the production of intricate parts for use in products ranging from high-end electronics to luxury watches.

According to Osbild, many existing micromachining techniques involve inefficient and inflexible mechanical and electrochemical processes that consume lots of energy while producing extensive waste and harmful

chemicals.

“Many industrial processes are quite old, which means they’re well studied, but also not environmentally friendly,” he said.

For Osbild and his team, the solution lies in laser technology – and more specifically, so-called ultrashort-pulse (USP) lasering. Using extremely short pulses of light lasting just quadrillionths to trillionths of a second to cut and structure surfaces allows far greater precision than a longer laser pulse or continuous radiation.

The higher first-time accuracy of laser processing reduces waste and also avoids the use of chemicals required in traditional processes. In addition, the technique gets around the need to replace tools as there is no wear and tear. It also minimises surface heating, energy loss and the need for coatings. USP lasers can process almost any material with micrometre-scale precision.

# Finger on the pulse

One of the obstacles the researchers face is that USP lasers require intense laser power to be efficient on an industrial scale.

“The drawback of USP lasers for years was that they were not powerful enough to be competitive for more industrial applications with big parts,” said David Bruneel, group research coordinator at LASEA, a manufacturer of industrial laser machines based in Liège, Belgium.

LASEA is working closely with the team at Fraunhofer ILT and other research partners from France, Germany, Greece, Luxembourg, the Netherlands and Spain to scale up USP laser technology for large-scale manufacturing.

The researchers are now involved in testing a 1-kilowatt USP system that they believe could significantly open up the range of applications for USP micromachining compared to current commercial systems operating at powers of 200 to 300 watts.

“Now we see a real rise in power, which will make micromachining a lot more productive,” said Bruneel.

The aim is to replace the whole micromachining manufacturing chain with a single digital USP laser system. This will incorporate 3D sensors and machine learning algorithms to maximise efficiency, help tailor designs and monitor waste.

# Industry 5.0

Tests show that this technology could potentially cut both waste and energy use by 90%. It can be applied in making a wide variety of products, from electronic components to razor heads and machines for embossing metal sheets used on car bodies and food and drink cans. The potential is huge.

LASEA has been involved in a number of EU-funded projects on the development of laser technology and photonics over the years, benefitting from both EU funding and the shared expertise of a wide range of European partners. This has helped the company to grow exponentially since 1999.

It has also helped to keep high-end jobs and technical know-how in Europe in a sector of strategic importance.

For Bruneel, EU funding in the laser manufacturing sector is helping to drive the region towards Industry 5.0 – in which people work together with advanced and AI-driven technology to contribute to environmental improvements and resilience, while also prioritising worker well-being.

“Europe is guiding the development of the region’s economies and technology towards a better world,” he said.

## Natural inspiration

LASEA was also involved in an earlier EU-funded research initiative called LAMPAS that developed a high-power USP laser system inspired by biological processes. Observing the self-cleaning properties of lotus leaves, for example, led to the development of surfaces with water-repellent features.

“Taking inspiration from biology is especially powerful because nature has evolved incredibly efficient surface functionalities,” said Professor Andrés Lasagni, a photonics and laser surface engineering specialist at Dresden University of Technology in Germany who coordinated the research.

The technology developed can be used for laser-produced surfaces with easy-to-clean properties in ovens, fridges and other household appliances, as well as anti-fingerprint surfaces. Laser-based treatment of appliances for heating water in dishwashers has also resulted in less accumulation of minerals, helping prevent the machines from getting clogged up.

Shark skin was another source of inspiration for surface designs that reduce friction and drag, with implications in sectors like transportation and aerodynamics.

“By mimicking these biological systems, we can create materials that perform better, last longer and contribute to energy savings,” said Lasagni.

## Driving force

Lasagni also stressed that the collaboration fostered by EU support to the sector is a driving force for European industry. LAMPAS, which finished in 2022, involved laser technology companies from Belgium, France, Germany and Spain.

“This level of collaboration is key to fostering innovation and ensuring that the latest advances in technology are not only developed in Europe, but also commercialised here,” he said.

Looking ahead, he said laser technologies are set to become more widely adopted as manufacturers across industries continue seeking ways to improve efficiency and performance while reducing environmental impact.

“The functionalities such technologies provide are not just nice to have,” he said. “They can fundamentally improve product performance in many industries.”

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## More info

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- LAMPAS
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- Industry 5.0