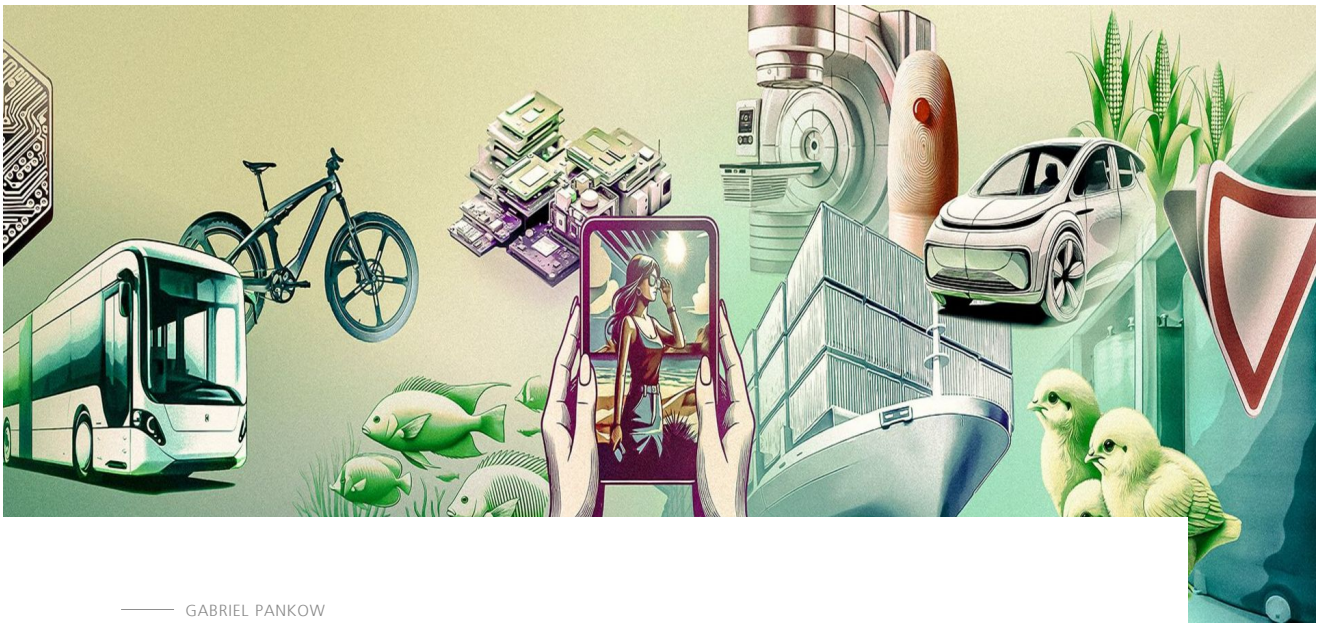


GABRIEL PANKOW

A job only lasers can handle – 6 applications for enhanced sustainability

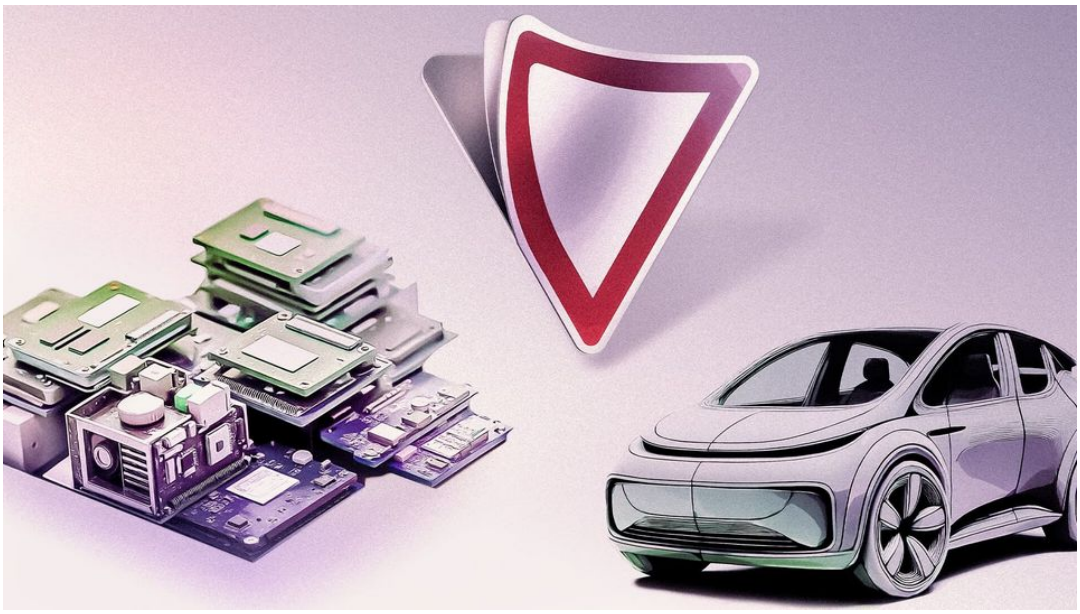
Everyone is talking about sustainability, but laser operators are actually making a difference. Lasers are not just tools for boosting efficiency – they are a key component in creating a more environmentally friendly industry. Below you will learn about six examples of innovative, cost-saving and sometimes surprising laser applications that contribute to making the world a better place.

The biggest challenge when it comes to recycling is separation. The more thoroughly and carefully disused appliances and items can be dismantled, the more raw materials can be recovered. However, much of what is used in production cannot be easily separated once it has been combined:

FINDING TREASURE IN SCRAP

Theory has it that recycling involves breaking things down into their constituent parts and returning the materials to the cycle without any loss of quality. In reality, however, we are often left with a massive pile of scrap. How can we separate it by type? The Fraunhofer Institute for Laser Technology ILT has developed a new process for this purpose, whereby a sensor uses laser emission spectroscopy to identify the chemical composition of the scrap as it passes on a conveyor belt. It is then sorted either by humans or an AI-supported automatic system. The laser method is also suitable for awkwardly shaped waste such as electronic scrap and vehicle parts. It can detect even the smallest quantities or alloy components of valuable raw materials like molybdenum, cobalt or tungsten. The laser detector ensures that far more materials are returned to the cycle than before.

Now for another two examples. In the production of electrodes for electric car batteries, companies coat films with valuable materials such as lithium, cobalt and nickel. Not all of them pass the quality check. A laser beam removes the wafer-thin layer, the precious dust is collected and returned to the cycle. Even if an aluminium traffic sign is outdated or the lettering has become worn, it is discarded as scrap, thanks to special films that are mandated and cannot be removed. However, a CO_2 laser can remove them quickly without leaving any residue.



Lasers can help with recycling, whether it's recycling road signs or e-vehicle battery waste or discovering treasures in scrap metal.

The ideal approach to using resources has always been to achieve the same result with less effort. It’s not an exaggeration to say that laser processing has been following this efficiency principle for decades.

The most energy-intensive step in the production of lithium-ion batteries is the drying of wet-coated electrode films. They pass through a convection oven up to one hundred metres in length, which blows hot air onto them. This requires substantial energy input, yet the drying efficiency is minimal. This is why scientists at RWTH Aachen University have explored the use of heating VCSELs to achieve the same result. The mini infrared laser sources dry the electrodes over a distance of just ten metres. The process is not only significantly faster than the oven method, but it also uses approximately 40% less energy.

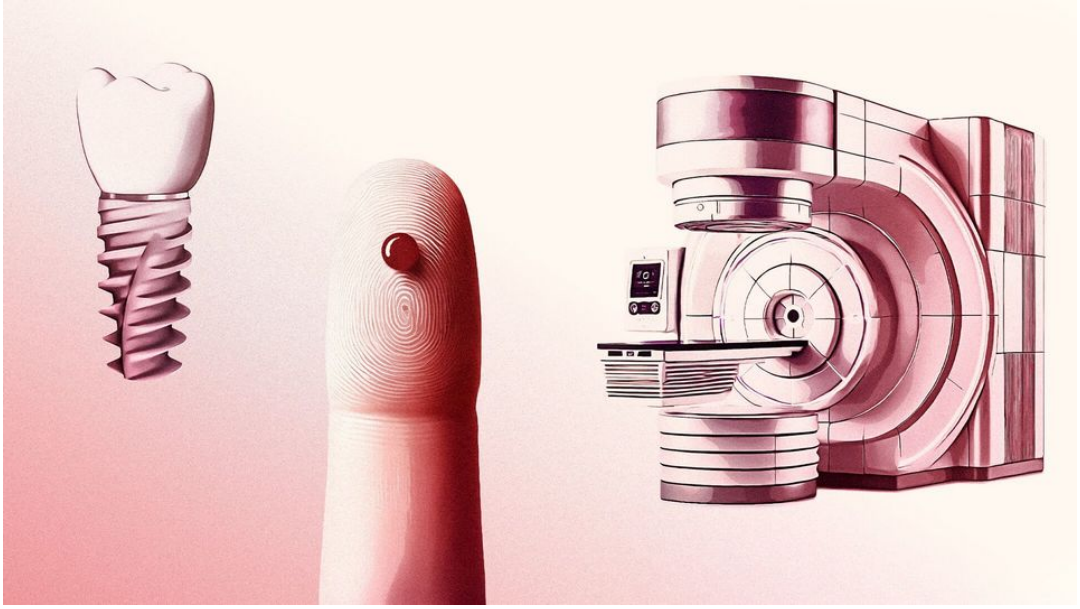
Further improvements in efficiency are also achievable in both photovoltaics and shipping. Within just one month, a PV module in the desert loses up to 30% of its power as it accumulates a layer of dust. Overlapping laser beams are used to create an actively dust-repellent surface structure. Microorganisms, algae, plants, mussels and barnacles colonise the hulls of ships, increasing fuel consumption by up to 60%. Beams from a diode laser can safely and completely remove this underwater contamination.

Laser technology helps conserve resources by drying battery films with minimal energy usage, reducing fuel consumption in shipping and ensuring clean photovoltaic modules.

TREATMENT FOR ALL

Hard X-rays are an effective treatment against cancer cells, but the experience can be extremely stressful for patients. Electron beam therapy would be both gentler and more effective, as electron beams can be focused with greater precision, allowing them to target cancer cells more accurately while minimising damage to surrounding tissue. However, electron beam devices are large and prohibitively expensive, which has restricted their availability. This is now changing thanks to the innovative laser bow wave method, which accelerates electrons in an entirely new way. This will make more effective and gentler cancer treatments accessible to far more people than before.

Lasers could also play a key role in improving global healthcare access in other areas. For example, despite using advanced technologies like laser-assisted digital holographic microscopy, Professor Bahram Javidi from the University of Connecticut was able to create a rapid blood test device using the most affordable and durable materials, specifically designed for regions with a poor medical infrastructure. In addition, many people cannot afford high-quality dentures. Significant progress in laser metal deposition, or metal 3D printing, is helping to provide more affordable dentures for everyone.



Industrial lasers not only lead to improved medical equipment. They also mean that more people worldwide have access to good healthcare.

POWERFUL FUEL CELLS

The energy transition involves more than just erecting massive PV systems, wind turbines and hydroelectric power plants (although they are part of the process!). It also involves modernising the power supply system to make it more adaptable to new forms of energy generation and improving the utilisation of alternative energy sources like hydrogen.

Large vehicles such as trucks, construction machinery and buses require a more powerful energy storage system to supply their engines with electricity – hydrogen and fuel cells, for example. One effective solution is the use of proton exchange membrane (PEM) fuel cells. A key challenge associated with this type of construction is maintaining efficient water and gas transport within the cell over the long term. This is where ultrashort pulse lasers come in, as they create functional structures and micro-holes within the cell. This technique ensures that PEM fuel cells are more powerful, more efficient and last longer.

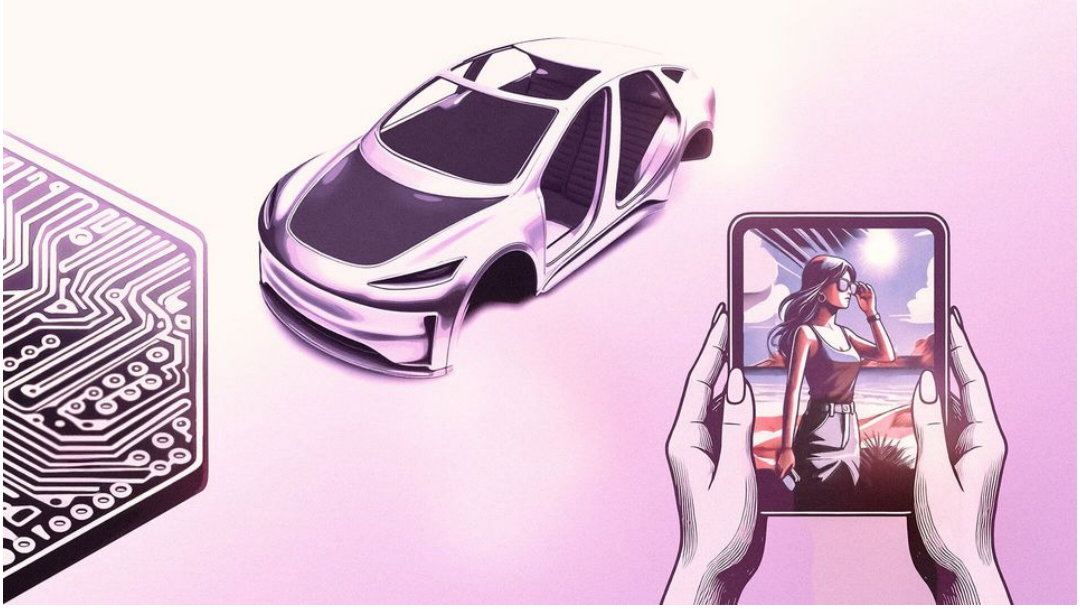
Highly efficient heterojunction solar cells require valuable silver for their strip conductors and contacts. A German start-up has developed a method to replace silver with copper by using a process that combines electroplating with laser structuring. To maintain stable power supply systems 24/7, operators of photovoltaic and wind power plants require flexible buffer storage solutions like redox flow batteries. A newly developed VCSEL-based laser welding method has now made production of these batteries significantly more cost-effective.

Laser technology could serve as a driver for more powerful fuel cells, cost-effective photovoltaic systems and flexible buffer storage, all of which help to maintain stable power supply systems.

NON-TOXIC SCREENS

Displays on smartphones, tablets, and e-readers must deliver a top-quality image at all times, even in bright light. In other words, the displays must be non-reflective and matt. Until now, achieving this effect has typically involved immersing the display glass in one of the most hazardous and toxic chemicals in the industry – hydrofluoric acid. However, TRUMPF's engineers are currently working on a laser process which they hope will remove hydrofluoric acid from production for good. Clean, ultra-short laser pulses on the display glass can achieve the same matt effect as the hazardous acid. The results achieved are flawless, so now it's simply a matter of scaling the laser process for production.

Lasers can also be used to clean other areas. For example, parts are often coated with oil, dirt or an oxidised layer. Laser beams vaporise impurities or simply remove oxidation layers. If only a few contact surfaces need attention, the laser targets these precisely. And light cleaning generates zero chemical waste for disposal. It has also been common practice to scratch away the top conductive layer (usually gold or copper) when preserving printed circuit boards, a process that generates toxic waste that is difficult to dispose of. Ultra-short pulses remove the copper or gold around the strip conductors very precisely, ensuring no heat penetrates the underlying material as well as being completely free of any corrosive chemicals.



Cleaning with light guarantees chemical-free production – whether it's for oil-covered components, reflective smartphone displays or cupriferous backing layers on printed circuit boards.

MICROPLASTICS FILTERS

Microplastics are particles smaller than five millimetres, down to the nanoscale. They are now present everywhere, from the deep sea to the Antarctic, and can be found in fish and even in the human bloodstream. The effects on living organisms and ecosystems have not yet been researched in detail, but initial findings are worrying. There is therefore a strong case for at least filtering microplastics out of wastewater to reduce their overall environmental impact. Unfortunately, microplastics are, by definition, incredibly small. This means that the holes in the filters must be correspondingly tiny. A consortium of companies and scientists has successfully used an ultrashort pulse laser to drill tens of millions of tiny holes to create a cyclone filter. To make the process more cost-effective, they split the laser beam to drill over one hundred holes simultaneously. The filter is designed to capture plastic particles larger than ten micrometers.

A European network of research centres, universities, businesses and agricultural associations has built a prototype for laser weed control. The AI-powered image recognition system in the autonomous vehicle detects weeds. A millimetre-precise pulse of energy from the fibre laser source is all it takes to eliminate the weeds. A laser can also be used to determine the sex of a hen's egg. Determining whether a chick is male or female is crucial, as it is common practice to cull all male chicks shortly after hatching. An automated laser process now puts an end to this cruel practice by determining the sex of the animals from the embryos inside the egg.

Global warming poses a key threat to our ecosystems, yet there remain many other “classic” conservation and animal welfare issues to be resolved in areas such as agriculture, livestock rearing and marine pollution.

GABRIEL PANKOW
SPOKESPERSON FOR LASER TECHNOLOGY