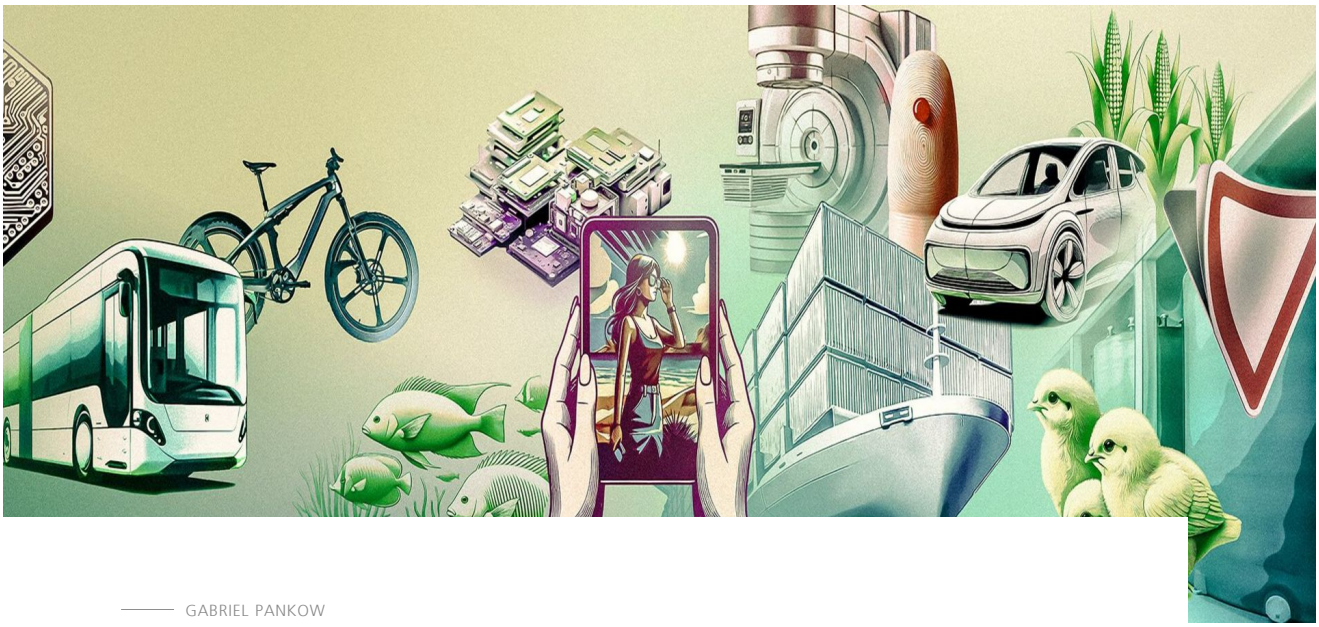


GABRIEL PANKOW

Only with lasers: 6 applications for more sustainability

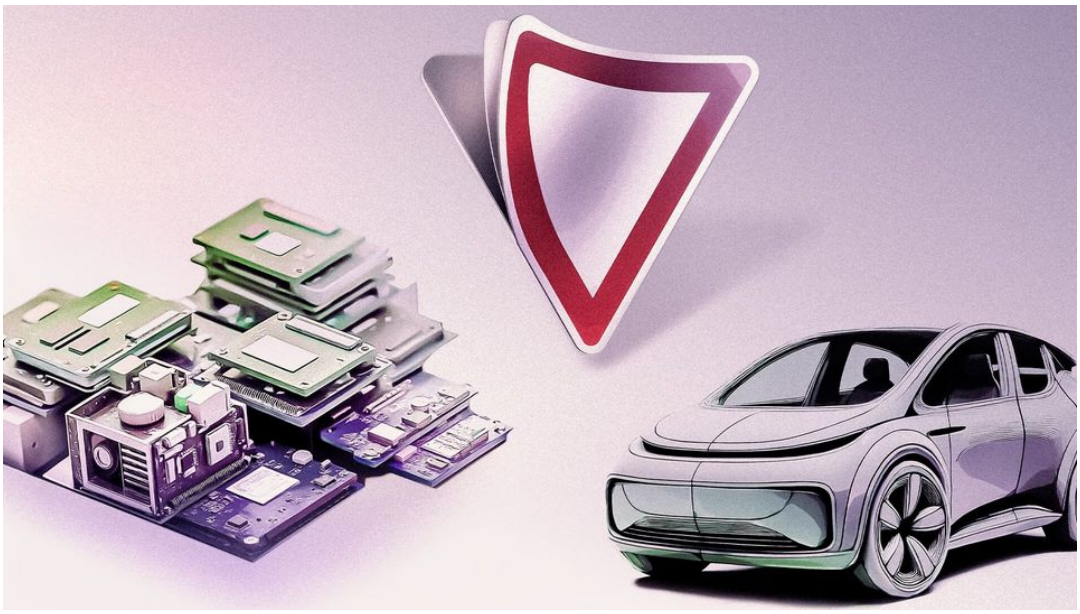
Everyone is talking about sustainability, but laser users are actually doing something. Because lasers are more than just tools for increased efficiency when it comes to innovations for sustainability - they are a key component for environmentally friendly industry. Get to know our six examples of innovative, cost-saving and sometimes even surprising laser applications, which are making the "Better World" project a success.

The biggest problem with recycling is separation. Appliances and other items can be taken apart when they reach the end of their useful life, and more raw materials can be gained when these things can be properly disassembled into small parts. But unfortunately a lot of what is joined together in manufacturing processes can often not be easily taken apart:

FINDING TREASURE IN TRASH

The theory: when recycling we dismantle things into their component parts and put the materials back into circulation without any loss of quality. The reality: a massive heap of junk. How can we get things sorted by type? The Fraunhofer Institute for Laser Technology ILT has developed a new process for this purpose: a sensor uses laser emission spectroscopy to identify the chemical composition of the scrap rushing past it on a conveyor belt. Afterwards, people or an AI-supported automatic system is used for sorting. The laser method is also suitable for shredded waste such as electronic waste and vehicle parts. It detects the smallest quantities or even just alloy components of valuable raw materials such as molybdenum, cobalt or tungsten. With the laser detector, many more materials will find their way back into circulation than before.

Two more examples: In the production of electrodes for electric car batteries, companies coat foils with valuable 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 returns to circulation. And even if a traffic sign made of aluminum is no longer up to date or the lettering has become unsightly, it is thrown away. The reason for this is that the special films that must be used do not come off However, these could be quickly removed without leaving any residue using a CO_2 laser.



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

The ideal way to use resources has always been to achieve at least the same result with less effort. It's not a far-fetched theory that laser material processing has been living by this motto of efficiency for decades.

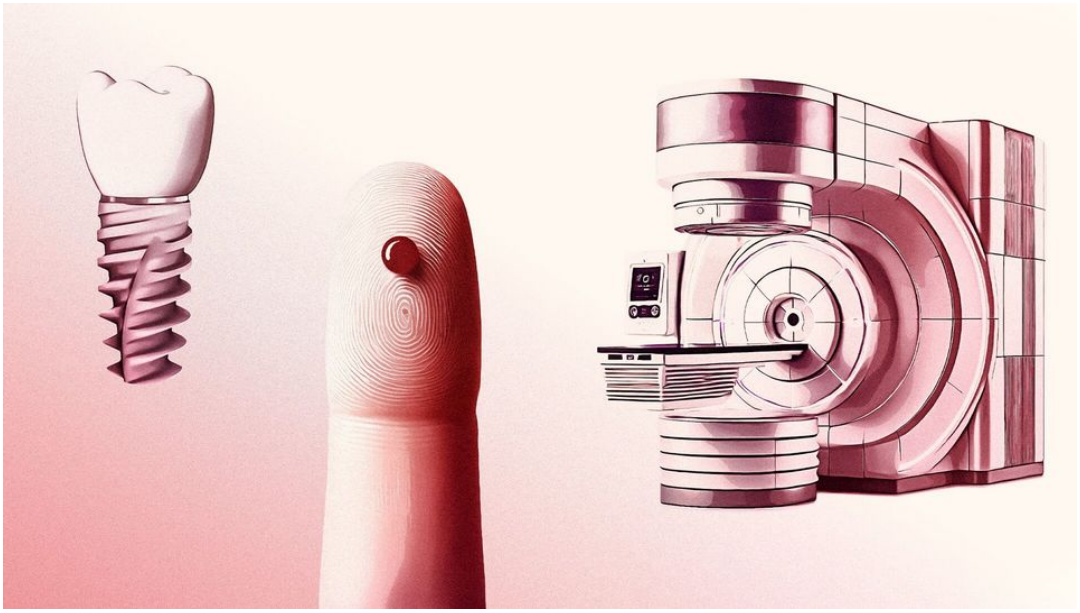
Even greater efficiency is possible with photovoltaics and shipping: within just one month, a PV module in the desert loses up to 30 percent of its output due to the growing layer of dust. Overlapping laser beams create an actively dust-repellent surface structure. And microorganisms, algae, plants, mussels and barnacles colonize the hulls of ships, increasing fuel consumption by up to 60 percent. Beams from a diode laser can safely and completely remove the vegetation under water.

Laser technology conserves resources: it saves fuel in shipping and ensures clean photovoltaic modules.

THERAPY FOR ALL

Hard X-rays are an effective therapy against cancer cells. But the treatment is also very taxing for patients. Therapy with electron beams would be both gentler and more promising, as electron beams can be focused more precisely and therefore hit the cancer cells more accurately without affecting the surrounding tissue. However, electron beam machines are huge and extremely expensive, so there are hardly any available. Both are now changing thanks to the so-called laser bow wave method, which accelerates the electrons in a completely different way. This will make better and gentler cancer treatments possible for many more people than before.

And lasers could also help more people around the world gain access to good healthcare in other areas, because although it uses really high-tech methods with so-called laser-assisted digital holographic microscopy, Bahram Javidi, professor at the University of Connecticut, was able to build a rapid blood test device from the cheapest and most robust materials possible, especially for regions with poor medical infrastructure. What's more, many people cannot afford high-quality dentures. The immense advances in laser metal deposition, or metal 3D printing, are leading to 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.

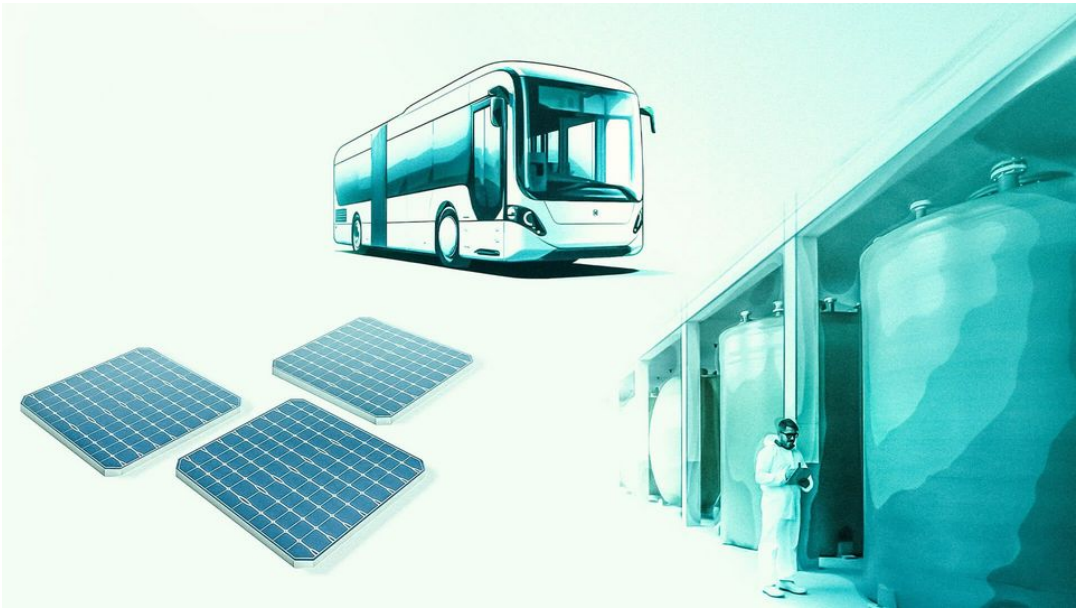
POWERFUL FUEL CELLS

The energy transition is more than just setting up massive PV systems, wind turbines and hydropower plants (but those things too!). It is also about getting the electricity grid fit and flexible for new electricity generation and making better use of alternative energy sources such as hydrogen.

Large vehicles such as trucks, construction machinery or buses need a more powerful energy storage system to supply their engines with electricity: hydrogen and fuel cells, for example. A good solution are so-called PEM fuel cells (Proton Exchange Membrane). A key challenge with this design is to keep the water and gas transport within the cell efficient in the long term. This is where ultrashort pulse lasers come into play: they create functional structures and micro-holes inside the cell. Thanks to this trick, PEM fuel cells are more powerful, more efficient and last longer.

Highly efficient heterojunction solar cells require valuable silver for their conductive paths and contacts. A German start-up has developed a method of replacing silver with copper. To do this, they use a method that combines electroplating processes with laser structuring. And to keep their electricity grids stable day and night, operators of photovoltaic and wind

power plants need flexible intermediate storage systems such as redox flow batteries. The newly developed VCSEL-based laser welding method now makes their production significantly cheaper.

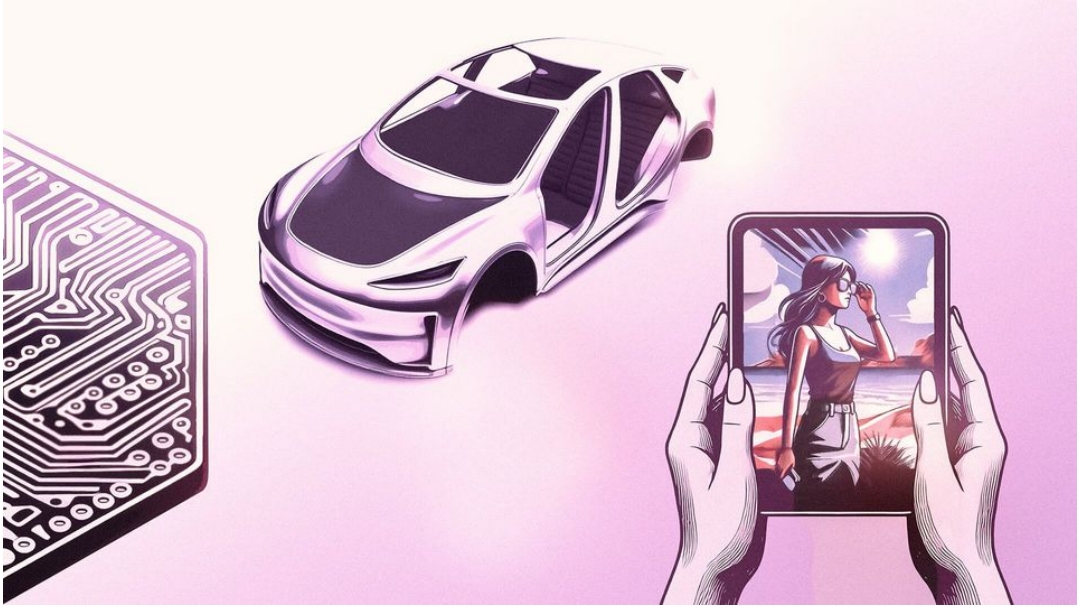


Laser technology could be a vehicle for efficient fuel cells, cheaper photovoltaic systems and buffer storage for stable power supply systems.

NON-TOXIC SCREENS

Displays on smartphones, tablets and e-readers should always provide an optimal picture. Even in bright light. In other words, they must not be reflective and should instead be frosted. And until now, this has only been possible by immersing the display glass in probably the nastiest and most dangerous chemical known to the industry: hydrofluoric acid. But the engineers at TRUMPF are currently developing a laser process that will keep hydrofluoric acid away from such production for good. Clean, ultra-short laser pulses on the display glass provide the same matting effect on the display glass as the toxic acid. The results are flawless, now it's just a matter of scaling the laser process.

And other areas can also be made cleaner by laser: components are often smeared with oil, dirty or have an oxidized layer. Laser beams vaporize impurities or simply remove these oxidized layers. If only a few contact surfaces are involved, the laser takes care of them specifically. And the chemical waste to be disposed of during light cleaning is reduced to zero. It was also common practice to etch away the upper conductive layer (usually gold and copper) when preserving printed circuit boards. This produces toxic waste that is difficult to dispose of. Ultra-short pulses remove the copper or gold around the conductors. So targeted that no heat penetrates the material underneath - and completely free of corrosive chemicals.



Cleaning with light ensures chemical-free production - whether for oil-smeared components, reflective smartphone displays or copper-containing carrier layers on printed circuit boards.

FILTERS FIGHTING MICROPLASTICS

Microplastics are particles that are smaller than five millimeters, down to the nanoscale. They are now found everywhere, from the deep sea to the Antarctic, in fish and in the human bloodstream. The effects on living organisms and ecosystems have not yet been researched in detail, but initial findings are worrying. So there is a lot to be said for at least filtering microplastics out of wastewater and reducing overall pollution. Unfortunately, microplastics are, well, micro, meaning the holes in the filters must be just as tiny. A consortium of companies and scientists has now managed to drill tens of millions of holes for a so-called cyclone filter using an ultrashort pulse laser. To make the process more economical, they split the laser beam and drill more than a hundred holes simultaneously. The filter catches plastic particles larger than ten micrometers.

A European network of research centers, universities, companies and agricultural associations has built a prototype for laser weed control: The autonomous vehicle's AI-supported image recognition identifies weeds. A millimeter-precise pulse of energy from the fiber laser source - that's it for the weeds. The laser can also be useful for sex detection in chicken eggs. The question: hen or rooster? The answer? Important. This is because it is common practice to shred all male chicks alive. An automated laser process now puts an end to this cruelty, as it recognizes the sex of the animals as embryos in 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.

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