PRESS RELEASE

Getting H_2 chain reactions under joint control

LKH_2 – Laser Colloquium Hydrogen 2023: Thinking in processes and collaborating in networks

Around 70 experts from industry and science met in September 2023 at the LKH_2 – Laser Colloquium Hydrogen on the Digital Photonic Production (DPP) research campus of RWTH Aachen University. The fall congress of the Fraunhofer Institute for Laser Technology ILT focused on possible ways to apply lasers in hydrogen production. Participants learned about the importance of thinking in terms of process chains during many presentations and the laboratory demonstrations at Fraunhofer ILT and the neighboring Fraunhofer Institute for Production Technology IPT.

Worldwide, manufacturers of freight transport vehicles have hydrogen drivetrains firmly in their sights: "The commercial vehicles of the future will not only need batteries, they will also need hydrogen," is what Martin Daum, chairman of the board of Daimler Truck AG, told Fraunhofer Magazine 3/23. Daimler Truck plans to collaborate with Toyota Motor Corporation on hydrogen drivetrains. In 2021, Daimler Truck, from Leinfelden-Echterdingen near Stuttgart, launched cellcentric, a joint venture with the Volvo Group, to build one of the largest production facilities for fuel cells in Europe. The laser, an all-round tool, has a central role to play here: It is already being used in the battery-electric 19-ton eActros truck.

Daimler Truck's two-track strategy with hydrogen and battery also coincides with the developments outlined by Prof. Arnold Gillner, Head of Business Development Research Markets at Fraunhofer ILT. At the LKH_2 – Laser Colloquium Hydrogen, he clarified this using a "Roadmap Hydrogen Market" of the Deutsche Energie-Agentur GmbH (dena) from Berlin. Both established and potential users, including the process industry, are increasingly recognizing the need for hydrogen. This also applies to areas such as the production of green steel.

The demand for green hydrogen is immense, as are the ideas for what the sustainable fuel can be used for. For this reason, many industries are looking at processes for producing fuel cells and electrolyzers in series. Lasers are ideally suited for this not only because they are extremely precise and can be integrated into existing production facilities, but also because the processes using them are very flexible and can be scaled up. Another advantage is that lasers are a green process because they reduce CO_2 emissions and consume fewer resources. According to Gillner, this is why lasers are also

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becoming increasingly important in hydrogen production. Two examples among many: First, ultrashort pulse lasers can produce hydrogen directly from salt water; second, cracking methane with laser processes is said to be three times faster than the conventional thermocatalytic process.

All these processes have one common denominator: They require process thinking in chains. This is best achieved when all players pull together. Gillner again addressed his vision of building a joint hydrogen platform, which the research market expert clarified with a call to the H_2 community: "We are looking for six industrial partners from small, medium-sized, but also gladly larger companies to join our 'Lasers in hydrogen technology' network." The tempting offers from Aachen: joint research and development projects, continuous exchange of know-how, and cooperation in the ILT's own hydrogen laboratory, which opened in 2022, Germany's largest test field to date for the entire H_2 process chain.

Aachen as a role model – Yesterday open-pit mining, today laser network

The participants in Aachen got to know several role models for networking: For example, Edwin Büchter, managing partner of Clean-Lasersysteme GmbH from Herzogenrath and project coordinator of the LASER.region.AACHEN alliance, reported on the opportunities for local partnership promoted by the German Federal Ministry of Education and Research (BMBF). In the KoLa project (combined laser processes in industrial manufacturing), for example, companies and scientific partners are working together to develop new process combinations to establish laser technology in electrified powertrains or in the hydrogen industry.

AI-controlled cutting: One second per anode-cathode pair

Another network focuses on the much hyped topic of artificial intelligence (AI): Since 2021, four industrial companies and two research institutes have been developing two demonstrators for laser cutting and laser welding in the BMBF joint project DIPOOL. A digital process online optimizer for intelligent laser machines plays a central role here, and the engineers are combining machine learning (ML) with a unique characteristic of laser tools, that they can be easily programmed and controlled, for the first time.

In the benchmark with other ML processes, a convolutional neural network (CNN) performed best at an accuracy of 98 percent. According to Dr. Frank Schneider, head of the Cutting Group at Fraunhofer ILT, ML has already proven its worth as a reliable cutting control system for the high-speed cutting of 0.5 to 3 mm thin bipolar plates made of metal and composite materials. This opens up interesting prospects for series

production. Schneider: "If the cutting processes are suitably designed and distributed, the processing time for a welded anode-cathode pair can be reduced to one second."

Sensor technology takes on an important function in the DIPOOL project: Precitec Optronik GmbH from Neu-Isenburg has developed sensor technology with AI software and the DIPOOL approach and integrated it into a latest-generation laser cutting head, including data interface. Precitec also uses experience from such joint projects in further developments such as the newly patented Enovasense sensor technology, which works on the principle of laser photo-thermo-radiometry. The clever interaction of laser and infrared sensor makes it possible to precisely measure the layer thickness of a wide variety of materials without contacting them.

According to Dr. Markus Kogel-Hollacher, head of R&D projects at Precitec, the system measures a typical coating of a bipolar plate that is only 10 µm thick with a possible deviation of only 0.1 µm. Another argument in favor of the process is that it significantly reduces work required for calibration. Kogel-Hollacher: "Materials and layers that are already known do not have to be calibrated again – only unknown coatings, layers or materials."

The measurement technology for laser welding comes from 4D Photonics GmbH in Isernhagen. It is an innovative multispectral sensor system that has already proven itself as a prototype in monitoring the joining process of bipolar plates. According to technology manager Sören Hollatz, the Lower Saxons have optimized the new 4D.TWO system during intensive trials at the German Electron Synchrotron DESY in Hamburg. The special feature: It not only monitors the laser process optically in the visible and invisible near-infrared range, but also eavesdrops on it with its microphone. Thanks to its real-time capability, it records laser processes in three channels and takes up to one million measurements per second to reliably detect and classify welding defects. The next step is to introduce AI into the system to detect defects even more accurately and reliably. Here, 4D Photonics will certainly also benefit from the experience gained in the DIPOOL project.

All 13 presentations could easily fill a small reference book. Interested parties can gain insight into the current state of research at Fraunhofer ILT in the field of hydrogen production and battery technology at the LSE'24 - Laser Symposium Electromobility in Aachen, Germany, January 23 and 24, 2024.

Image 1:
Prof. Arnold Gillner, Head of Business Development Research Markets at Fraunhofer ILT: "We are looking for six industrial partners from small, medium, but also gladly larger companies to join our 'Lasers in hydrogen technology' network."
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Image 2:
Dr. Frank Schneider, head of the Cutting Group at Fraunhofer ILT: "If the cutting processes are suitably designed and distributed, the processing time for a welded anode-cathode pair can be reduced to one second."
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Image 3:
Innovative neighbors: The program of the Laser Colloquium Hydrogen 2023 also included a visit to a facility at the neighboring Fraunhofer Institute for Production Technology IPT, which, among other things, demonstrated continuous roll-to-roll production of bipolar plates for fuel cells as part of the CoBiP project, which also includes Fraunhofer ILT.
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Image 4:
Insider event of the hydrogen community: 70 participants met at the 4th Laser Colloquium in the fall of 2023 to learn about new approaches in laser-based hydrogen production.
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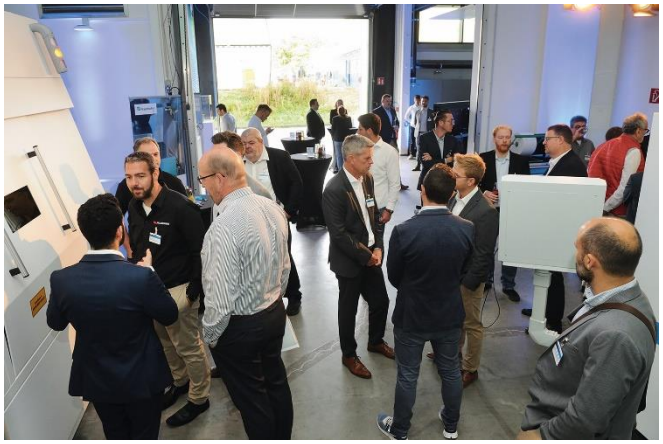

Image 5:
A flying visit to the hydrogen laboratory: Germany's largest test field to date for the entire H_2 process chain demonstrated the continuous series production of electrolyzers and fuel cells.
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