IPH Institut für Integrierte Produktion Hannover

Press information

Optimizing 3D-printed components for laser beam welding

IPH and LZH jointly develop an expert system for laser transmission welding of additively manufactured plastic components

Hannover, 1 June 2021. Welding 3D-printed components with the laser: This is the goal of the scientists at the Institut für Integrierte Produktion Hannover (IPH) gGmbH and the Laser Zentrum Hannover e.V. (LZH). In the new research project "QualLa", they want to develop an expert system that supports small and medium-sized enterprises in optimizing additive manufacturing processes – so that the printed components can subsequently be welded soundly with the laser.

For injection-molded plastic components, laser transmission welding is already an established industrial joining process. For components from the 3D printer, however, the joining does not yet work because cavities and boundary layers in the 3D-printed components prevent a uniform weld. These cavities and boundary layers are individual to each component because, in additive manufacturing, no two components are alike. Even components from the same series are only identical on the outside; the internal structure can be different.

To enable small and medium-sized enterprises (SMEs) to weld 3D-printed plastic components with lasers without analyzing each component in detail in advance, the IPH and LZH scientists want to develop an expert system and bundle process knowledge in this computer program.

In the project "Quality assurance in laser welding of additively manufactured thermoplastic components (QualLa)", the researchers are looking at fused deposition modeling (FDM) for this purpose. In this additive process, thin strands of molten plastic are superimposed layer by layer.

Even before the 3D printing process starts, the expert system is supposed to provide recommendations on which material, which layer thickness, and which layer orientation are best suited to achieve the highest possible transmission – in other words, the highest possible permeability for the laser beam. Thanks to this preliminary work, it will be possible to weld the printed components optimally afterward.

In addition, the scientists want to develop a method to measure the transmission with spatial resolution. This involves determining for an individual component at which points the laser beam is transmitted and to what extent. This data will then be used to control the laser transmission welding process with the help of the expert system.

If the laser beam is less transmitted at a certain point, the laser power must be increased. If the component is more light-transmissive at another point, lower laser power is sufficient. The researchers' goal is to develop a process control system that adjusts the laser power as a function of transmission so that a uniform weld seam is produced – even if the 3D-printed component does not transmit the laser beam uniformly.

The scientists want to use machine learning methods to process the information. The plan is to use neural networks, a type of artificial intelligence that makes the expert system capable of learning. The system will learn to recognize correlations between various input variables and the print result independently and thus predict the expected transmission.

Laser transmission welding can be used to join components made of thermoplastics – contact-free, automatable, without mechanical, and with low thermal stress. Two joining partners – one made of transparent, one of non-transparent plastic – are welded to each other with a laser beam. The laser beam penetrates the transparent joining partner, and as soon as it hits the non-transparent plastic, the laser light is absorbed and converted into thermal energy. As a result, the plastic in the joining area melts, and a weld seam is created.

IPH and LZH are working closely with the industry on the research project. The committee accompanying the project includes companies from the fields of laser technology, additive manufacturing and plant engineering. Other companies are welcome to participate in the project – companies involved in artificial intelligence or additive manufacturing are particularly sought after.

Further information is available at qualla.iph-hannover.de.

Funding notice

The IGF project no. 21571N entitled "Quality assurance in laser beam welding of additively manufactured thermoplastic components (QualLa)" of the Forschungsvereinigung Forschungsgemeinschaft Qualität e.V. (FQS), August-Schanz-Straße 21A, 60433 Frankfurt am Main, Germany, was funded by the German Federal Ministry for Economic Affairs and Energy via the AiF within the framework of the program for the promotion of joint industrial research (IGF) based on a resolution of the German Bundestag.

About the IPH

The Institut für Integrierte Produktion Hannover (IPH) gemeinnützige GmbH (which literally translates into Hannover institute of integrated production) is a service provider for production technology and was established in 1988 at the Leibniz University in Hannover. The IPH offers research and development, consultation and qualification concerning the subjects of process technology, production automation, logistics and XXL products. Its customers include companies from the sectors of tool and mould construction, machine and plant construction, aerospace and the automotive industry, electro industry and forging industry.

The business has its headquarters in the science park Marienwerder in the northwest of Hannover and currently employs about 70 people, of which about 30 are scientific personnel.

About the LZH

As an independent, non-profit research institute, the Laser Zentrum Hannover e.V. (LZH) stands for innovative research, development and consulting. The LZH is supported by the Niedersachsen Ministry for Economic Affairs, Employment, Transport and Digitalisation and is dedicated to the selfless promotion of applied research in the field of photonics and laser technology. Founded in 1986, almost 200 employees are now working for the LZH.

The focus of the LZH lies on the fields of optical components and systems, optical production technologies, and biomedical photonics. Interdisciplinary cooperation between natural scientists and mechanical engineers makes innovative approaches to challenges from the most different areas possible: from the development of components for specific laser systems to process developments for the most diverse laser applications, for example for medical technology or lightweight construction in the automotive sector. Eighteen successful spin off companies have emerged from the LZH up to now. Thus, the LZH has created a strong transfer between fundamental science, application oriented research, and industry.

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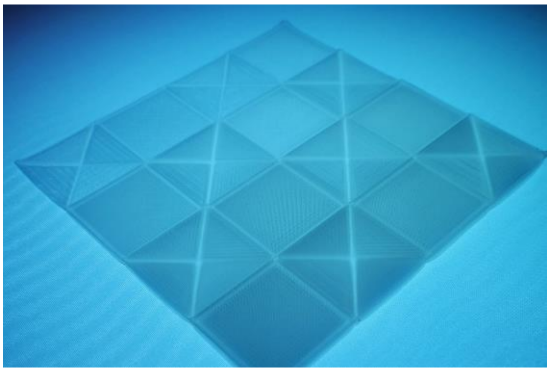
Images



3D-printed sample component: The so-called transmissivity, i.e. light transmission, varies depending on the layer thickness and layer orientation. (Photo: LZH)

Fused Deposition Modeling (FDM): In this 3D printing process, plastic components are built up layer by layer. (Photo: IPH)