Fraunhofer IPA

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

Additive Manufacturing with Inkjet Printing

Enabling functional, multi-material structures

3D inkjet printed test structure, including printed electrical circuits and integrated.

Inkjet

Inkjet printing is one of the most popular methods of digital printing. Although it is mainly used to decorate paper and paperlike materials, the technology is also gaining importance as an industrial process.

The fact that inkjet technology is also used for some additive processes – better known as 3D printing – is far less well known.

Possibilities of additive manufacturing

Among other things, inkjet printing serves as the basis for various additive manufacturing processes, such as powder bed printing and direct printing (also known as photopolymer jetting or Polyjet®). These inkjet based "3D printing" processes benefit from the rapid development in industrial digital printing and are becoming established in a wide variety of applications.

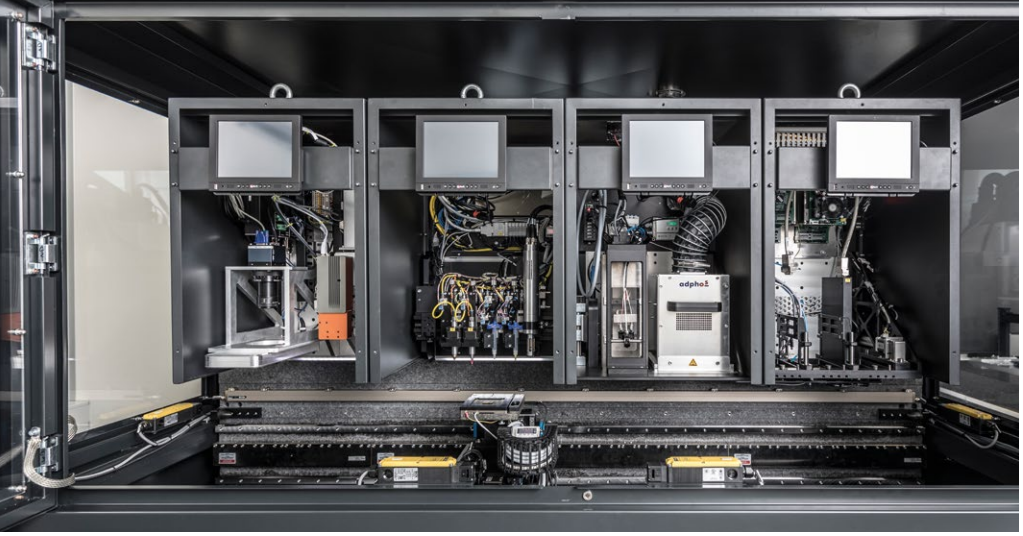
Even optical components such as lenses or custom-made eyeglasses can now be produced on the basis of photopolymer jetting. Photorealistic 3D prints are also possible, as is the production of multi-material components consisting of materials with different degrees of elasticity.

Binder jetting can be used to create colored illustrative models and also large and highly complex casting cores from sand. Additionally, a variety of plastics as well as ceramics and metals can be processed. In the case of ceramics and metals, a green body is first produced in a 3D printing process, which is then sintered in a conventional process to create the finished component.

Inkjet technology is also a promising option for tissue engineering (the artificial production of biological tissue). Advantages such as high resolution and precise dosing ensure that cell-loaded inks are transformed into three-dimensional structures similar to those found in the body. As a result, personalized cartilage replacement, for example, is no longer merely a vision of the future.

All these applications benefit from the properties of digital printing technology: the efficient, precise and selective application of material enables not only high-resolution components but also good process scalability.

The ability to place different materials in specific positions in a component is the key to producing multi-material structures.



Modules of the NextFactory system based on a combination of 3D printing and microassembly processes.

Biomimetic vessel structure during the additive process.

Challenges

The number of materials that can be processed is currently still limited and it is not yet possible to achieve all the desired properties. Therefore, in order to open up further fields of application, new materials need to be developed and specifically adapted to the process. To implement the technology in the manufacturing industry, pre- and post-processing steps require further automation – for example, feeding of the machines with raw materials and removal of supporting structures. Due to the history of model-making processes, such automation solutions have not yet become established.

In addition to all their advantages, the various additive processes also have restrictions that must be taken into account when designing parts.

From the engineer's knowledge of the use of suitable software tools to the correct placement of components in the production plant, the successful use of additive processes depends on a large number of factors along the digital process chain.

Services

To make the best possible use of the advantages of additive manufacturing technologies for your application, we offer comprehensive support:

- Selecting and evaluating additive technologies according to your specific requirements
- Developing processes for all polymerbased additive operations, including biomaterials, ceramic and metallic green bodies
- Feasibility studies
- Constructing test benches and process modules
- Assistance in material development
- Choosing software solutions

Application examples

In the EU project "Nextfactory" (Grant Agreement No. 608985), inkjet based 3D printing was used to integrate conductive structures directly into additive components. Thanks to the additional integration of a microassembly process, micromechatronic components can also be integrated into the 3D printed component. Thus, in the future, it will be possible to integrate individual components with electronic, mechatronic or sensory functions.

By equipping inkjet based 3D printers with drop watching systems, Fraunhofer IPA was able to support the aimed optimization of printing materials in order to adapt improved 3D printing materials to existing systems.

In the field of biomedicine, techniques for processing biocompatible materials without oxygen have been developed, thus enabling biomimetic, cell-populated scaffold structures to be generated by 3D printing.

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