

High-viscous material inkjet printer

Inkjet as manufacturing process

A jaw implant that allows the body's own bone to re-grow. Can you imagine that? We can. Within the European Custom Fit project we are working with various partners on the development of new Rapid Manufacturing processes. The aim is to manufacture unique customised products that can be specially geared to individual requirements. In addition to this application, inkjet technology can be used for other purposes.

Rapid Manufacturing and inkjet technology

Rapid Manufacturing (RM) means producing products layer by layer, which makes it possible to manufacture customised products in small series without having to use expensive tools. TNO research focuses on developing new and improving existing RM processes.

Several RM processes already use inkjet technology to manufacture layered products. The print heads used to do this are able to process liquids with a maximum viscosity of 30 mPa•s. TNO goes further and has developed a print head that is able to process high-tech materials with a viscosity of between 20 and 500 mPa•s at ambient temperature. In general the advantage of these high viscosities is that the material properties of the product will be better, which enables the manufacturing of functional products.

The European Custom Fit project

Within the European Custom Fit project (www.custom-fit.org) TNO focuses on the development of an RM process that is able to manufacture custom-made implants of bio-compatible and bio-degradable material. The ultimate aim is to make a jaw implant from a material in which the body's own bone can re-grow. The implanted material will then be broken down by the body.

To stimulate cell growth in the implant, growth stimulators can be added selectively. But not the same cell type is desirable



The print rig with the three print heads developed by TNO

everywhere and cell growth must not be stimulated to an equally extent everywhere. So a measured quantity of growth stimulator can be added at each position in the implant. In fact, the process enables the build of graded structures.

To be able to construct such 3D products, a machine is needed that can print, or process, the various high-tech and curable materials. To model the products that have to be made TNO has developed Innerspace: a CAD program that is able to define the various

materials in a 3D product and also translate this into input data that is suitable for an RM machine. The program therefore describes not only the shape of a product but also its internal structure.

TNO's inkjet equipment

The machine developed by TNO contains three print heads that are able to deposit various UV curable materials selectively next to each other on a moving substrate. This occurs, depending in part on the viscosity of the liquid, at a frequency of between 10 and 140 kHz. The stage moves at a speed up to 6 m/s and the printing volume can be adjusted from 0.5 to 4.0 ml/min. These speeds can be adjusted according to the application.

The standard print heads work at temperatures of 20°C to 80°C. A modified print head can even operate at up to 350°C. The higher the temperature, the lower the viscosity of the liquid, which can facilitate the printing process. The volume of a droplet can be selected, depending on the settings used, from nanolitres to picolitres.

The print head that is used to process the high-viscous material has been fully developed by TNO and is patent protected.

Other applications

The print head developed by TNO is able to process high-viscous material into mono-dispersing droplets a size of around 100 μm (35 to 250 μm) in size. Compared to other processes this print head is able to generate droplets with a very small spread in size, which also minimises the spread in quality. The droplets can then for example be dried to a powder. Using high-viscous material enables drying on the basis of a higher dry matter content than in conventional techniques.

What does TNO have to offer?

We can offer companies added value in many ways through our contract research. Our own patented technology enables us to process high-viscous materials. The interest in the printing of these kinds of materials is

growing. In the processing of these materials into a product, it is essential that the material to be printed and the printing process are compatible. And this is where our expertise lies.

- Our unique system enables us to process different high-viscous materials (up to 500 mPa•s), something that conventional print heads cannot do. Just think of solvent-free inks and inks with a high load such as filled materials.
- The process that enables various materials to be printed simultaneously is quite unique. Currently three print heads are being used for this. More may be added in the future.
- In addition to our own Continuous Inkjet System we have various commercially available drop on demand systems in house, including MicroFab PolymerJet, Solderjet, Dimatix DMP, Trident Pixeljet and Spectra Nova. These help us investigate whether your material can be used in commercially available printing systems. We can also modify or optimise the material so that it can be used.
- TNO also has knowledge in house of the printing of metals to make conductive metal tracks. We are working on the development of various processes in this field.
- In other words, we can develop the optimum process for your material.



The monodisperse droplets and the ultimate goal of the Custom Fit project: the jaw implant

Rapid Manufacturing

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3D graded product made of three high viscous materials



The print head