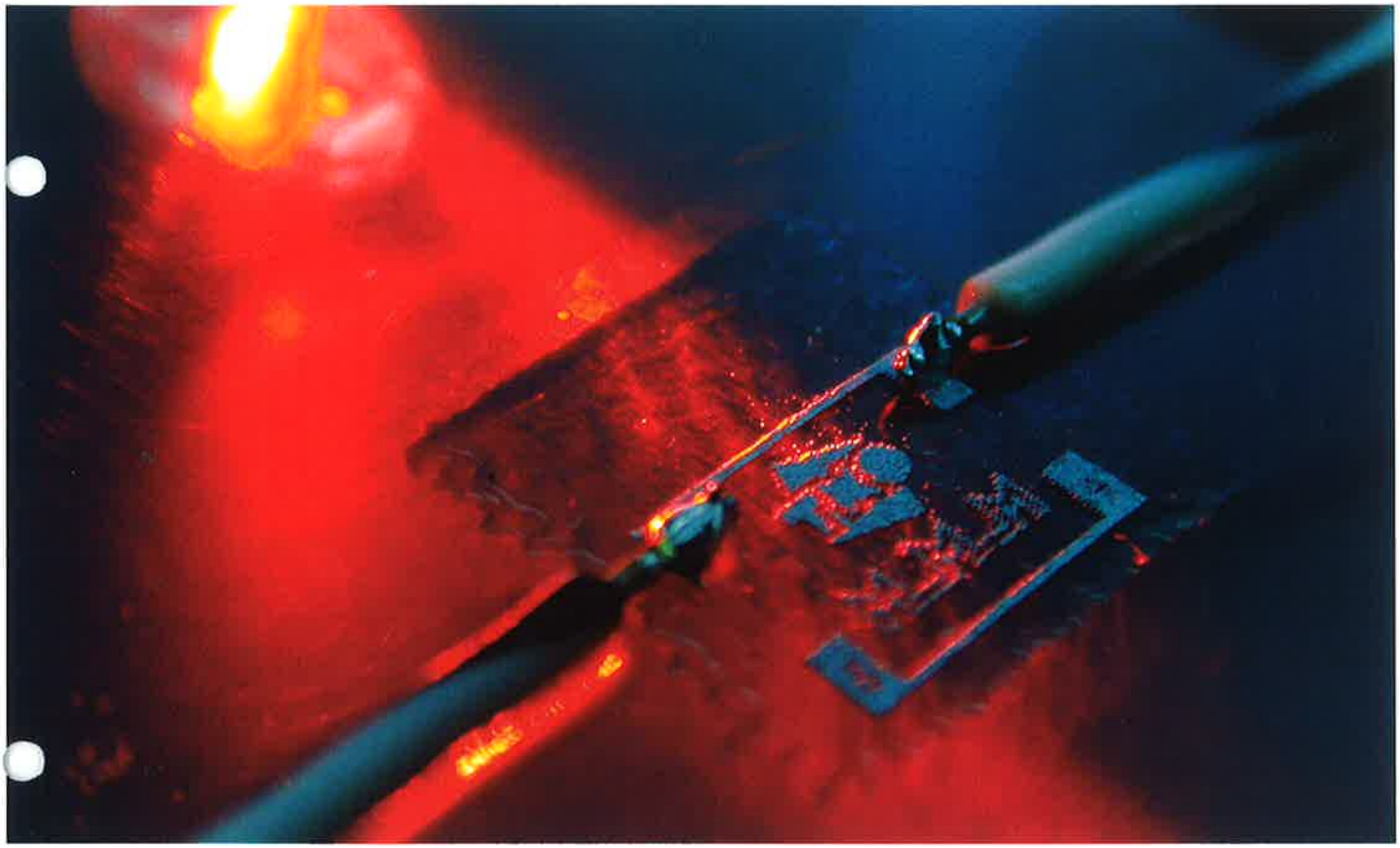
TNO | Knowledge for business

Multi Material Manufacturing

New steps forwards, new opportunities



In recent years, TNO Science and Industry has done in-depth research into Multi Material Manufacturing, the integrated application of different materials to a single product without auxiliary equipment. Now that a significant number of successes have been achieved, it is time to develop this knowledge further, together with businesses, into commercially appealing items. This could be where you come in.

Materials give products specific properties. The traditional way of manufacturing products, in which different materials are combined, is not always quick or practical, partly because of assembly and particularly because of the heavy investment required in auxiliary equipment, even in the case of a few pieces or a small series. There are often limitations on product geometry and sizing as well. Having completed its research programme, TNO Science and Industry is convinced that Multi Material Manufacturing offers a solution.

From the very start, TNO Science and Industry has worked intensively on research and development relating to Rapid Prototyping, Rapid Tooling and Rapid Manufacturing. These are usually Layer Manufacturing

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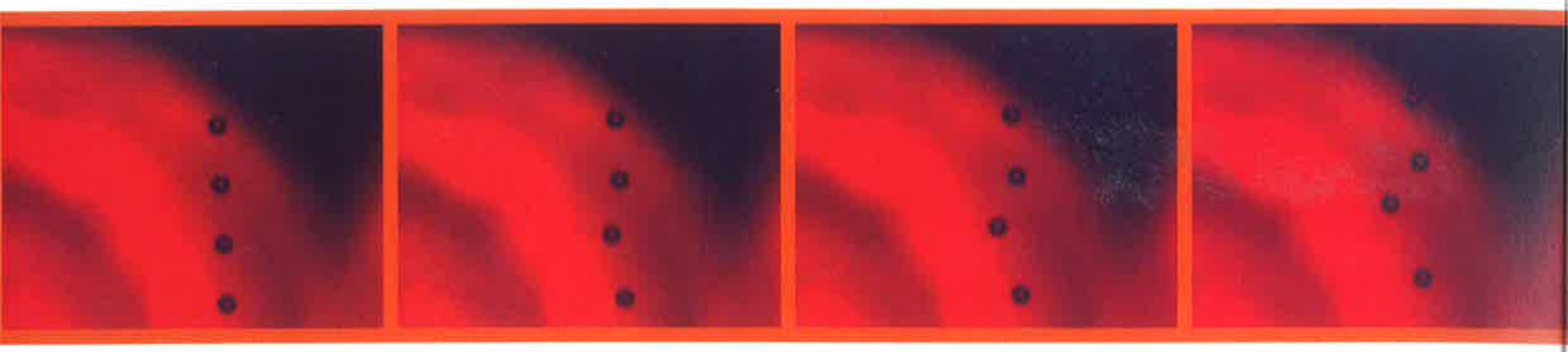
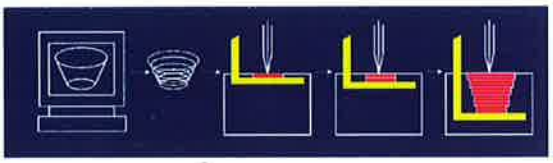
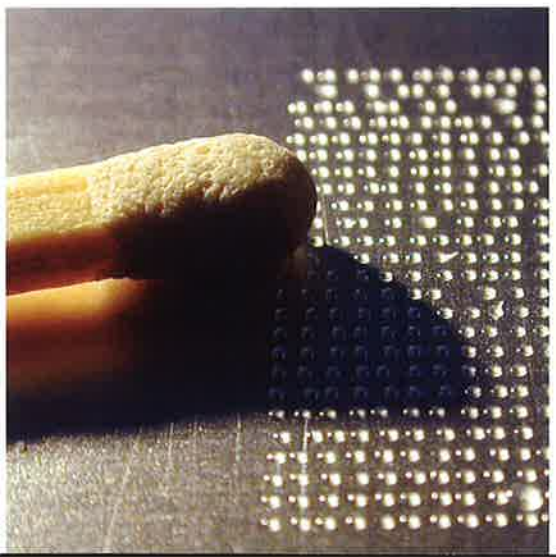


Technologies (LMT), in which a product is manufactured layer by layer. This method offers many possibilities in many areas. For example, TNO Science and Industry believed it was possible to apply different materials in a single production run, such as a conductive material and a non-conductive material, or a flexible one and a non-flexible one.



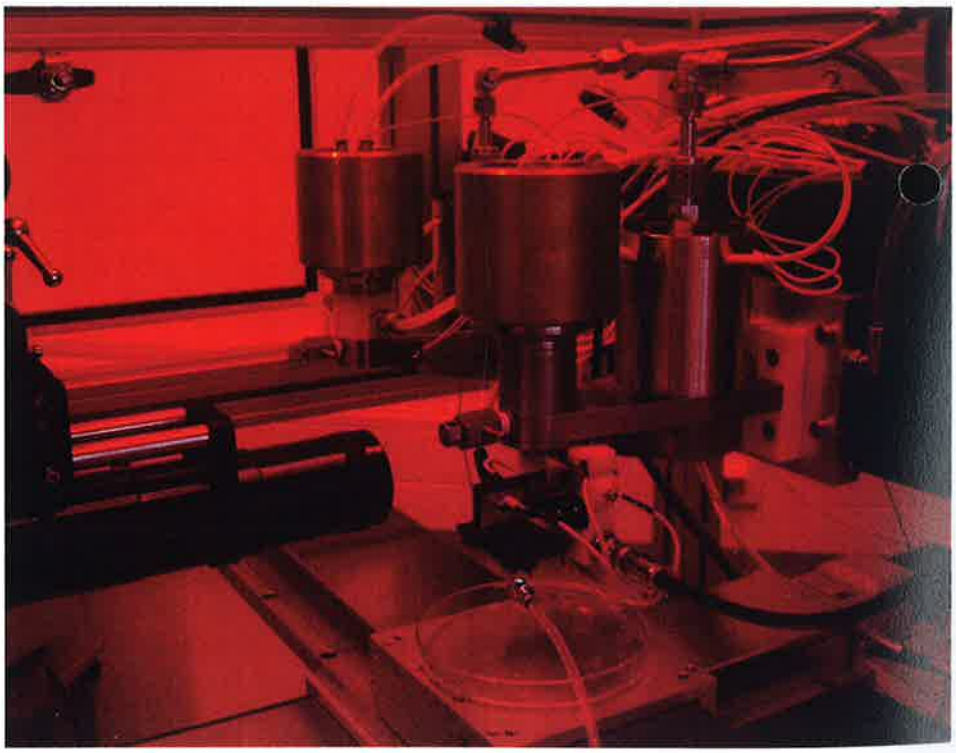
Polymer jetting

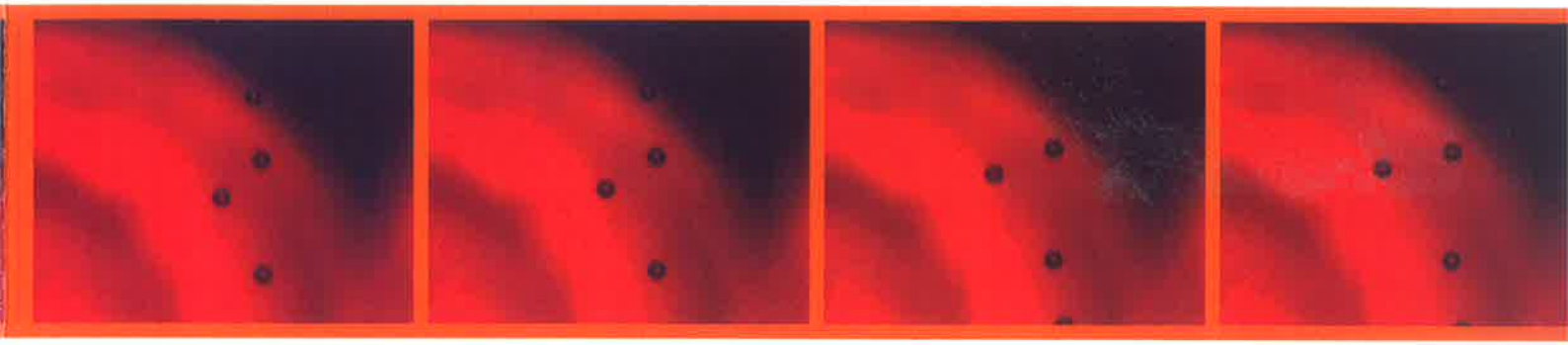
TNO Science and Industry concentrated on 3D printing (3DP), based on inkjet technology, as this LMT process has the most potential for fast production, simultaneous processing of different materials and also depositing material on a small scale. The small scale does not refer to the output, as a print machine can make larger quantities of products quickly, but to the dimensions of the droplet of material: 80 microns. This means a high degree of precision.



One of the most important parameters in a print process is the viscosity of the material used. Current print systems are able to process material with a viscosity of up to 20 mPa/sec. It is important for the quality of the final product, however, for the material to have the correct functional properties and be durable. This is a problem if the viscosity of the material cannot be greater in processing. TNO Science and Industry set itself a goal of processing a material of at least 200 mPa/second, 10 times greater than available systems. To achieve this, the starting point was a continuous system and a UV-curing polymer developed in-house. Among other things, a nozzle and recirculation system were developed for the material, which is cured after printing. This system even allows material with a viscosity of up to 400 mPa to be processed – 20 times greater than existing systems. This value even applies to viscosity at processing temperature; viscosity at room temperature can actually be higher. No other print system in the world can do this as yet.

Nevertheless, a continuous stream of 20,000 droplets per second is not a product yet. The next challenge therefore involved extracting droplets from the jet so that they can be deposited in specific places. The polymer was modified so that it can be given a charge, which allows the droplet to be





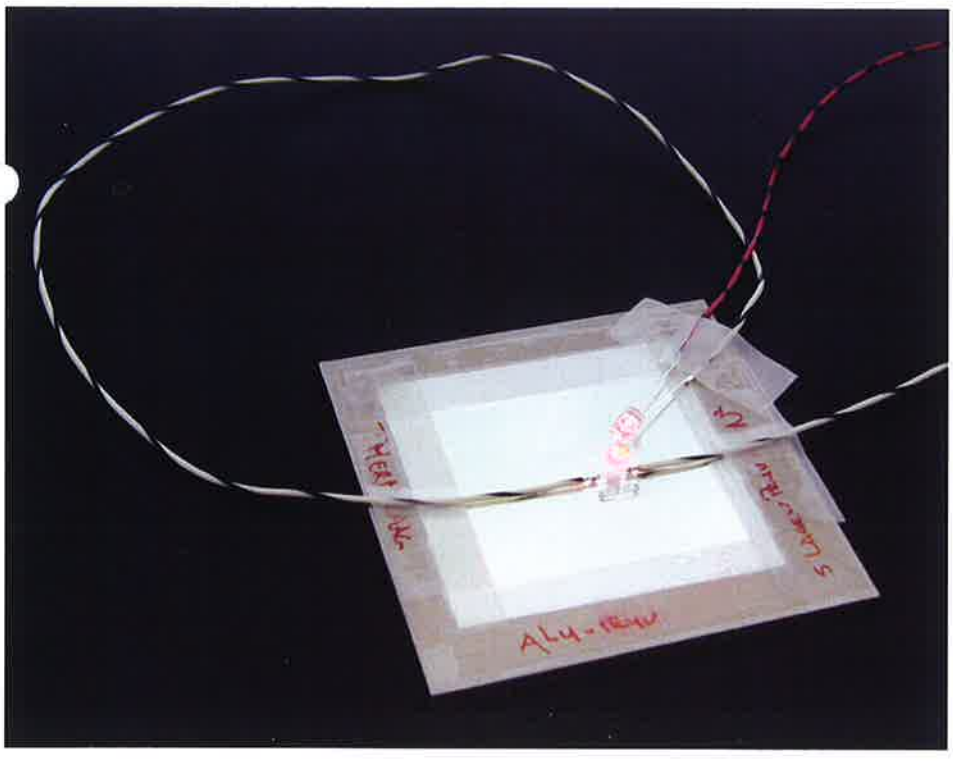
guided. The series of photos at the top of this page covers a timeline in which one in four droplets is diverted from the jet. The other unused droplets are captured and recirculated.

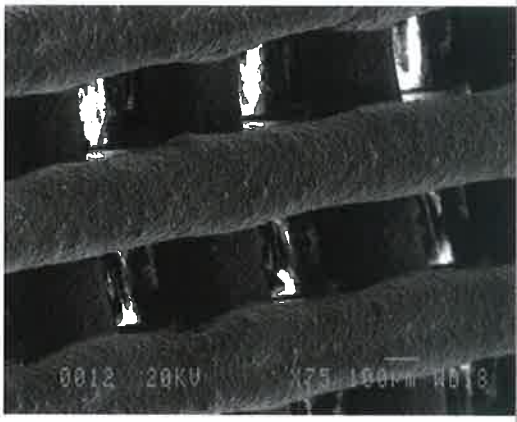
Adding metals

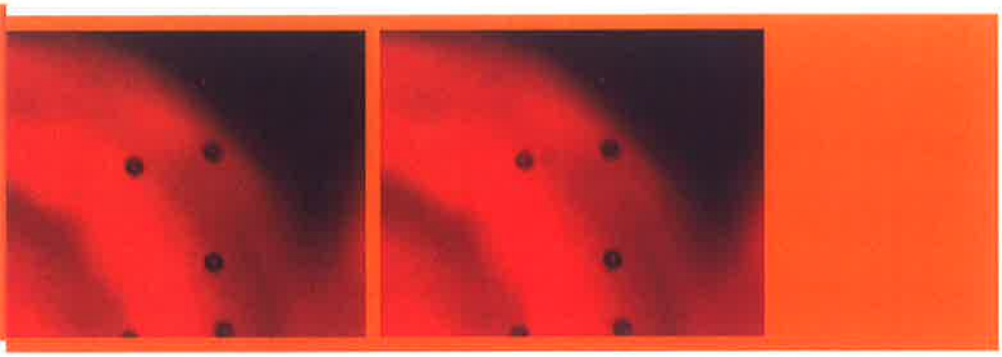
Sometimes it is faster and smarter to combine existing knowledge or technologies into new ones, so TNO Science and Industry starts by exploring the potential of what already exists. Solder jetting was selected to be integrated with the new print system for polymers. This made it possible to manufacture products in which conductive and insulating materials are combined. For each layer, the polymer is deposited on the production platform first, then the metal. This is not necessarily possible every time, but TNO Science and Industry has discovered the thermodynamic conditions in which this can be achieved.

Combining with ceramics

Another part of the research investigated how viscous ceramic pastes can be used in Multi Material Manufacturing. The LMT process that is most suitable for this is FDM (Fused Deposition Modelling). An extensive analysis has been made of the flow behaviour of ceramic pastes during production of three-dimensional structures with various critical aspects, such as overhangers. This method is now used to produce grids in which bacteria and cells can diffuse. Products were then made in which conductive and non-conductive ceramics were combined, such as a small run of miniature ovens. These can admittedly be produced by other means, but then the masking cost is often an overly large investment.







Possibilities in brief

Multi Material Manufacturing is highly suitable for functionally and geometrically complex products, such as:

- products with mechanical strength with locally an electrically conductive or even insulating function;
- medical products, such as implants with adhesion to bone and good moving properties in joints;
- heavily stressed components, such as turbine blades, in which strength and heat resistance are essential;
- products with chemical components, such as batteries;
- products in which materials with varied or very varied expansion coefficients are used, such as optical parts for satellites;
- products with precise dimensions, such as mobile telephone antennas.

Applied research means that TNO Science and Industry now has a great deal of knowledge and experience in print systems, materials and designs for Multi Material Manufacturing. This has specifically resulted in:

- a patent on the print head that was developed;
- a patent pending for making polymers conductive;
- an understanding of which materials can be processed together in one single production process;
- knowledge of critical factors in design and production;
- a method to visualise droplet jets in 3D print systems.

This means you may be able to benefit with TNO Science and Industry in:

- producing existing products more quickly and with better functional properties;
- developing new products;
- making existing materials suitable for new applications;
- improving existing print systems (troubleshooting and R&D);
- marketing a print system for Multi Material Manufacturing.

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