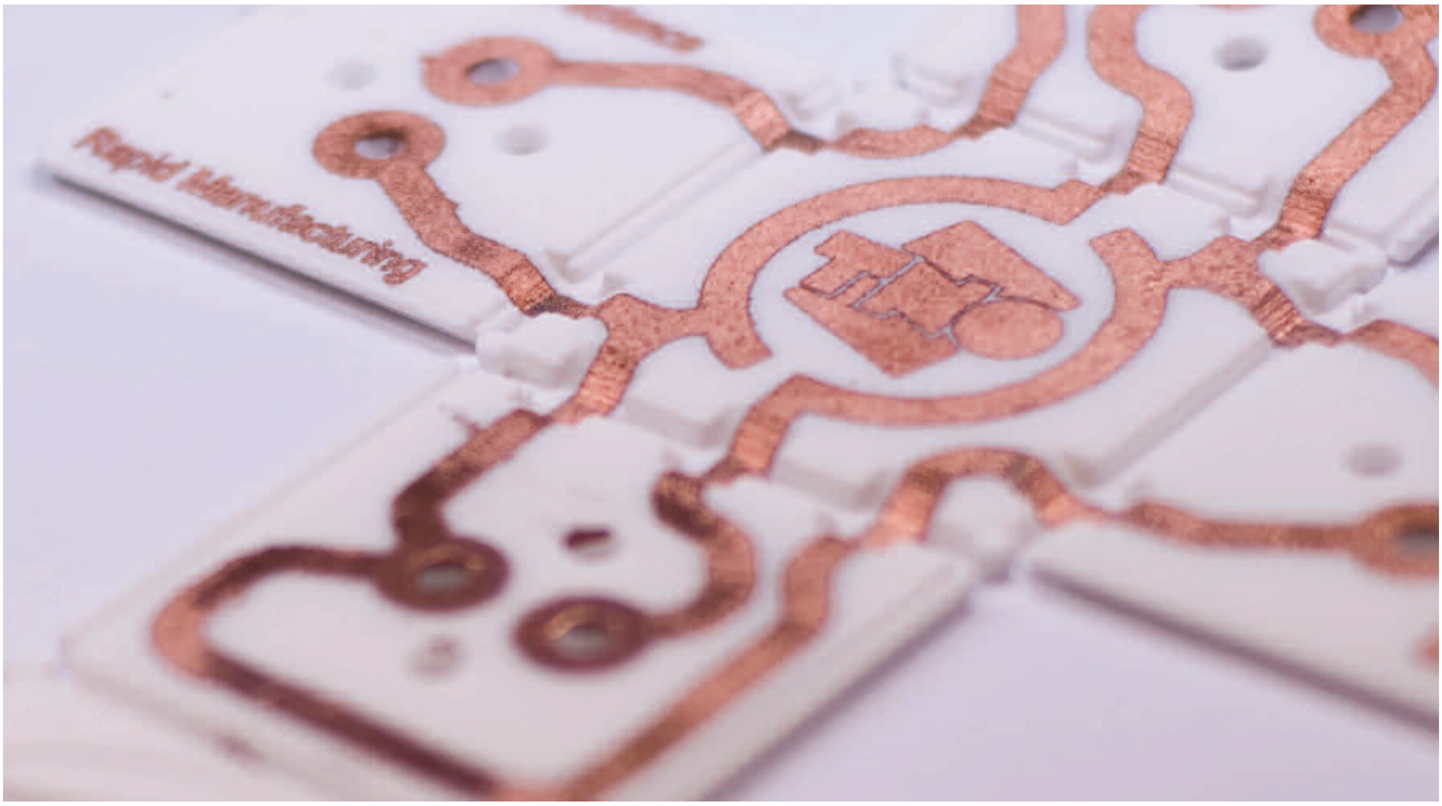
TNO | Knowledge for business

Digital printing of conductive tracks

Rapid manufacturing in printed electronics

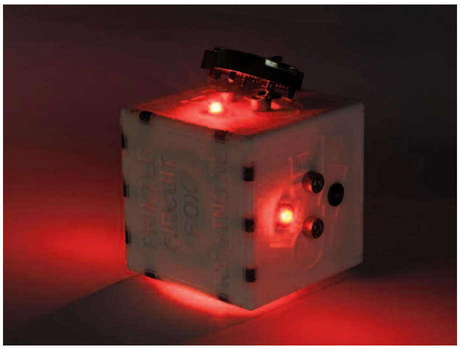


Flexible circuits are used in a wide range of applications from computers to vehicles but perform the same fundamental function: the transportation of electrical current in 3D paths. Current manufacturing technologies go a long way to satisfying the market's existing cost-based commercial drivers but TNO has developed a new and more flexible manufacturing process that both could both reduce cost and boost the performance and functionality for end users through the integration of the new FCBs (Flexible Circuit Boards) into their devices.

Rapid manufacturing and inkjet printing

Rapid Manufacturing (RM) is a process whereby products are manufactured layer by layer. This makes it possible to manufacture customised products in small series without having to use expensive tools. TNO research focuses on developing new, and improving or combining existing, RM processes.

By making use of existing RM technology, Laser Sintering, with inkjet printing technology, conductive tracks can be printed onto laser sintered, thermoplastic substrates to produce high resolution, mass customisable conductive copper tracks for use in 3D MID technology.



The flat part with the conductive tracks on it folded to a box

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TNO: combining rapid manufacturing design knowledge and printing technology

In order to enhance the processes, TNO combines design knowledge optimised for rapid manufacturing with knowledge of making conductive tracks using printing technology.

When making electronic housing, the costs must be minimised. In rapid manufacturing technology, the cost increases per cm^3, so instead of printing the 3D box, the box or geometry is unfolded to a flat plane with all the necessary hinges and snap connections integrated. This can be done with every foldable shape.

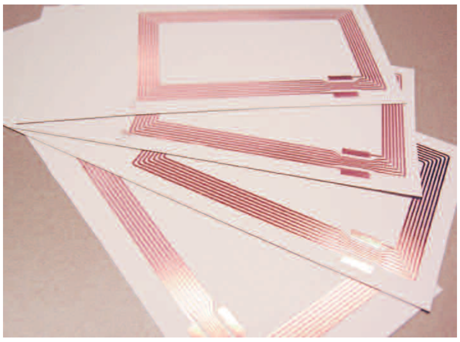
Laser sintering produces the flat plane, which can then be folded together into the 3D box. Since all surfaces are sintered in the same orientation, the surface finish on the final 3D shape will be the same on all sides.

The unfolded box is essentially a 2D part and can be processed with standard 2D inkjet printing equipment. To ensure a continuous printing pattern at the recessed flexure hinges, smooth angles are incorporated at those points where the print pattern crosses the hinges. If laser sintered nylon is not used, in some cases the substrate has to be pre-treated (for example surface abrasion, plasma and/or laser), to ensure good adhesion of the printed pattern and the metal used.

During this process patterns are printed with ink that contains a small portion of palladium. The palladium acts as a seed for the reduction of soluble metal salts, thus creating copper or nickel on the printed pattern that forms the conductive track. Electrical components can then be soldered on this track in a conventional way.

TNO is currently using Vipem (Vipem Hackert GmbH) and CIT (Conductive Inkjet Technology Ltd.) seed inks in this project that is a spin-off from Flextronic, a European FP6 project. The process is additive and flexible, in contrast to traditional production processes that require masks, stamps, multiple production steps and based on removing instead of applying copper.

Printing on textile, and gold plating afterwards



Printing on foils

Finally, the technology could benefit from being a more flexible manufacturing process which allows mass customisation of components with maximum tooling and, therefore, allow viable production of batches of one.

Applications

Possible process applications include:

- Electronics on foil - cheap fast and flexible;
- Electrodes in cloth - less obtrusive medical sensors (additional retrospective gold plating is required);
- Combination with LS gives semi-3D structures (integrated antennas or electronic shielding);
- Printing connections for LED lamps directly on heat sink (LED greenhouse grow lamps).

Printing on textile

LED's soldered on a printed Laser Sintered part with printed conductive tracks

High-end Equipment

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