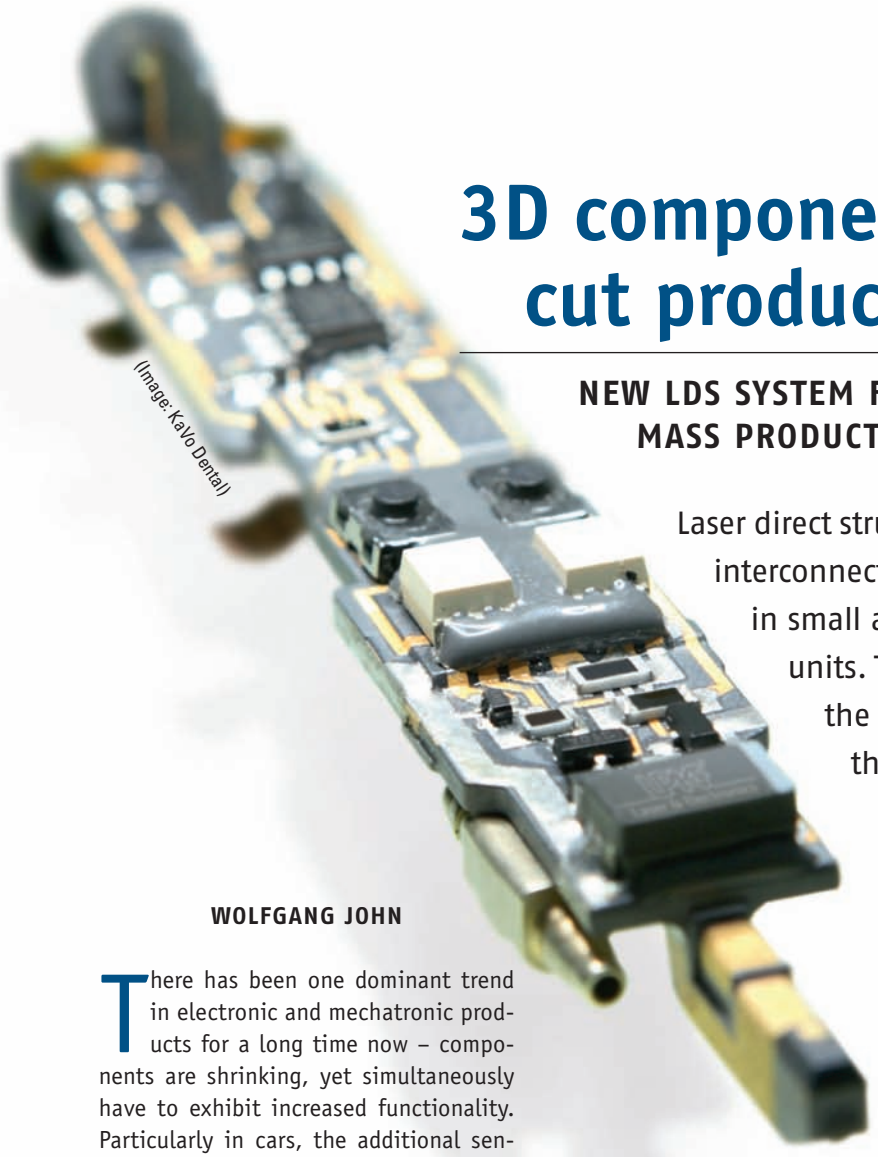

(Image: KaVo Dental)

3D components cut product costs

NEW LDS SYSTEM FOR COST-EFFICIENT MASS PRODUCTION

Laser direct structuring (LDS) has previously allowed 3D interconnect devices to be produced cost-efficiently in small and medium runs or even as individual units. The new Fusion3D system from LPKF cuts the structuring times and costs to around a third, thus making three-dimensional LDS interconnect devices attractive for the mass market.

WOLFGANG JOHN

There has been one dominant trend in electronic and mechatronic products for a long time now – components are shrinking, yet simultaneously have to exhibit increased functionality. Particularly in cars, the additional sensors and components for new driver assistance systems, including their cabling, require an increasing amount of space that is not readily available. They also make vehicles heavier, which is also undesirable (the wiring harness for a BMW 3 Series now weighs roughly 30 kg). Then there are the rising costs for manufacturing and installing the systems, which does not appeal to OEM or potential customers.

In communication technology, manufacturers are under extreme pressure to constantly bring new products to market in a very short timeframe, all in order to maintain their commercial position. And, of course, in order to succeed in the market these new products must have a collection of unique selling points that sets them apart from the mass of competitors. This calls for MID (molded interconnect devices), a technology that makes new products with previously unattainable functionality possible.

Increased functionality thanks to MID

MID means that conductors can be attached to three-dimensional plastic components and electronic components can be arranged in a very small space. This enables chips to be stylishly stacked in their assembly or aerials for smartphones or netbooks to be created on the housing in order to save space. At the same time, integrated functionality also reduces the number of individual components, eliminating a range of production steps and thus automatically saving additional costs and simultaneously delivering a higher quality of components.

Various methods are available for attaching conductors to plastic components. Hot embossing employs a stamp tfor pressing thin, flexible films onto the component. The surplus film is then removed. The process is simple and it works with a large number of materials, but it is unsuitable for very fine conductors and cannot achieve genuine three-dimensionality and more complex circuits. With sandwich molding, the interconnect device is produced first from plastic. A second plastic, one that can be metalized, is only deposited where conductors will subsequently run. The process allows almost unlimited design freedom in three dimensions, but the two molds required make it expensive. Production of fine conductors is also problematic. The relatively long lead time before this kind of product can come to market is an additional factor – the lead time for development of the molding tools alone is roughly two months.

As in many areas of manufacturing, the incomparable flexibility of lasers is open-

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ing up totally new perspectives in MID. In this subtractive process, the laser removes layers of metal where they are not required, or opens a resist for a subsequent etching process. The technology prerequisites reliable laser performance and extensively metalized components.

not limited by cost or technical grounds either. The path from prototype to series production is short and cost-effective, allowing the company to respond quickly to the needs of the market (Figure 2).

The LDS process has already achieved success in a wide range of applications.

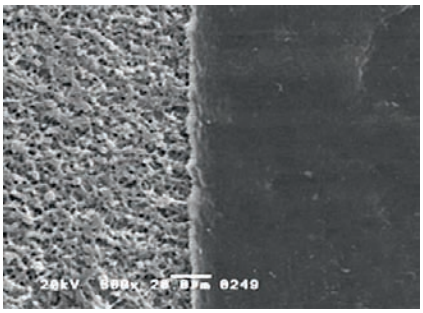
2 From a simple molded part to a fully equipped three-dimensional interconnect device

Laser direct structuring

The laser direct structuring (LDS) process patented by LPKF is more convincing from both a technical and an economic perspective. The LDS process uses a thermoplastic that is doped with a laser-activated metal/plastic additive. When the laser beam strikes the plastic, the metal complex breaks down and forms a roughened track. The metal particles act as seeds for the subsequent metalization. The laser draws the required structures onto the component and the conductor layers are then precisely deposited on these tracks in a plating bath. Copper, nickel and a gold finish can be applied in turn (Figure 1).

This is where the great flexibility, speed, resolution, and precision of the laser comes into its own. Changes to conductor paths only requires new control data to be send to the laser unit. This enables different functional components to be produced from a single basic component, depending on the design of the circuits inscribed on them. And because the control data for the laser can also be switched during production, an operator can manufacture small and medium-sized runs cost efficiently. One-off production is

The best known product group is complex aerial structures for high quality cell phones, PDAs and laptops. The technique has also proved effective in compact and high performance medical technology, pressure sensors and a coupling system for digital model railways. A pipette system with automatic volume detection, a steering wheel switch for the BMW Z4, the handlebars for the BMW K1300 motorcycle, seat adjusters, control cabinet modules and solar sensors for climate control in cars are also produced using LDS technology. At present, research is even in progress into the production of multi-layer LDS components.



1 The structure activated and roughened by the laser beam (left) is subsequently metal coated

Cell phones – smaller and more powerful all the time

Increased functionality with an ever smaller volume is a key requirement in the communications industry. Thanks to LDS, up to twelve aerials can currently be integrated into a cell phone. However, cell phone manufacturing is mass production and demands a considerably higher throughput than is normal for small and medium-sized runs. This is where the new ›Fusion3D‹ laser structuring unit from LPKF comes into play (Figure 3). Up to four laser heads work simultaneously on a precisely manufactured granite base plate from seven possible positions. This increases the throughput compared to previous systems by up to a factor of five, and cuts the processing time by up to 75 percent. Feed times and component rotation are eliminated.

The standard version of the Fusion3D has a laser focus of 65 µm diameter. This enables conductors with a width of 150 µm to be realized at a spacing of 200 µm. With different laser sources and optimized focusing, the system can create even finer structures, significantly surpassing the limits of other MID processes.

3 The new Fusion3D laser structuring unit from LPKF

4 The layout of a structure can be adapted on the computer in little to no time and immediately transferred to the component (Image: Iskra)

The system saves the production data and all parameters, and this can then be retrieved at any time. The software supplied distributes the control data to each individual laser head, thus optimizing cycle times. In conjunction with robotic automation, this guarantees speed, accuracy and maximum reproducibility while simultaneously minimizing personnel costs and downtimes. The Fusion3D is designed for continuous operation. It combines great flexibility, efficiency and short times to market with the option of mass production – which also recommend it for many other applications.

Growing market potential

As it is a software-based production system, it is only necessary to change the structure template file for the next product. This simplifies production and ensures minimal downtime, optimum utilization of system capacity and correspondingly low unit costs.

With its ›MicroLine3D‹ and ›Fusion3D‹ systems, LPKF supplies the ideal technology for future markets. They can be used for everything from one-off production through to mass-production. The advantages of MID technology are most noticeable where maximum functionality is required. Thanks to the third dimension, they open up totally new perspectives for designers, with performance that cannot be achieved using conventional methods.

Design steps

To make developers' work easier, LPKF provides a direct interface to LDS in the MID module for Nextra. Here, 3D molded shapes can be conveniently designed and virtually fitted with conductors and electronic components. The features available include a 3D splitting tool. The LPKF software uses the three dimensional CAD data to generate the optimized control data for the structuring process (Figure 4).

The design rules specially tailored to LDS explain the general parameters and assist in laying out the circuit. With the LDS rules the optimum process advantages of the method can be achieved from the component layout phase onwards.

With its LDS technology, LPKF is heading in the right direction, as the production method is increasingly replacing conventional manufacturing processes. For example, the Fusion3D systems already installed have increased capacity to up to 100 million aerials per year. Dr. Ingo Bretthauer, Chairman of LPKF, expects LDS technology to increasingly expand out of the high-end sector and gain a foothold in the mid-price cell phone market.

MID has huge potential

The key to LDS is: ›function follows form‹ – which not only allows for new functionality but also visually new products. Use of defined plastics complies with the RoHS regulations and recycling is easier than with PCBs, for example. Because the entire process takes place under one roof, there is no need for sophisticated and costly just-in-time management or for incoming inspections.

Particularly for companies in the automotive industry, the use of LDS is ideal, as engineers have to combine electronics and mechanics as efficiently as possible, while at the same time saving space. And there is even more fertile ground to work on, such as the development of aerial modules for UWB (ultra wide band) and MIMO (multiple input and multiple output), which can also combine satellite services such as GPS and SDARS.

Summary

The possibilities of LDS technology are a long way from being exhausted. MID applications will probably never be able to replace the entire wiring harness on a car, but they can drastically reduce its complexity, weight and costs, while simultaneously adding new functionality. LDS technology not only replaces existing components, but also allows unique functions and layouts to be achieved.

AUTHOR

Dr. WOLFGANG JOHN is a Senior Consultant in LDS at LPKF Laser & Electronics. He has spent his entire career working at the boundaries between chemistry and electronics. Since 1994, he has been involved in the ongoing development of MID technology.