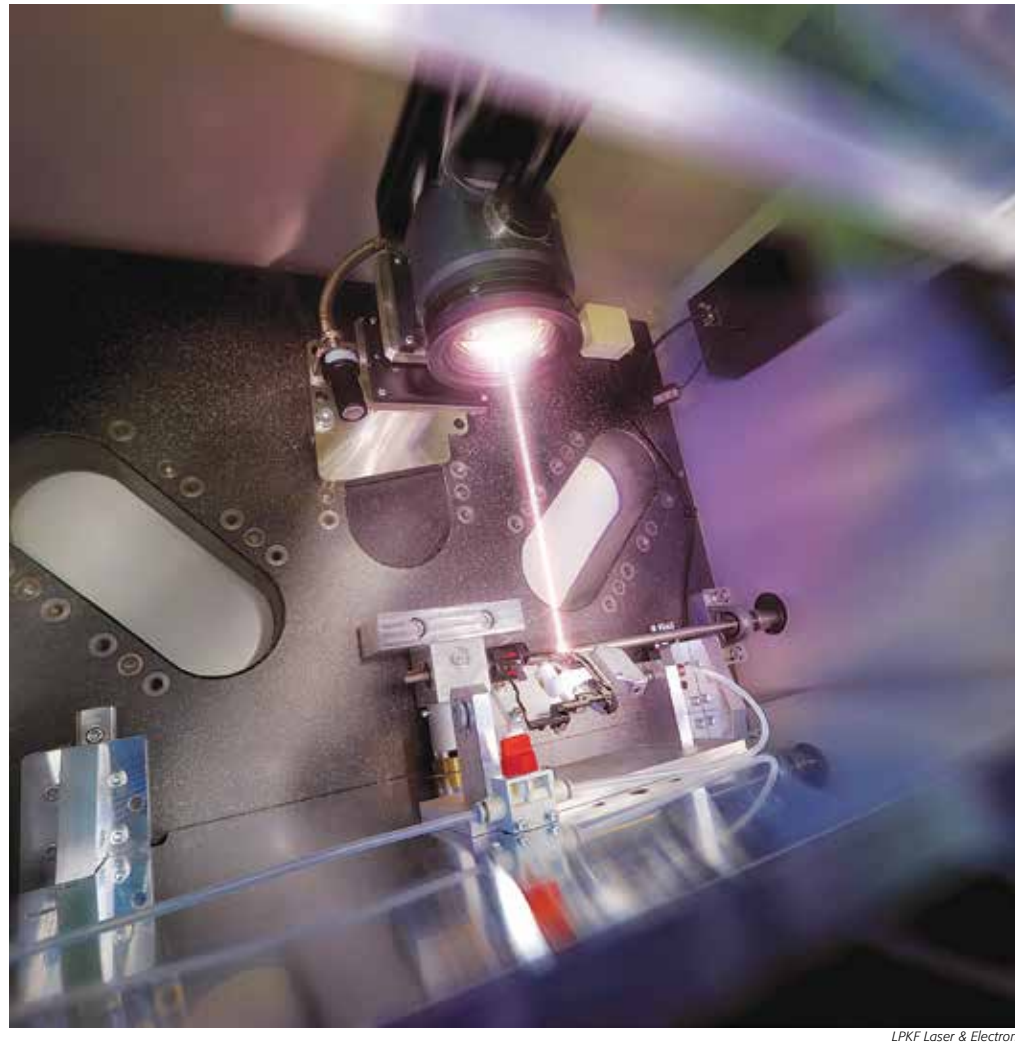
Space Saver

Emerging technology adds traces that shrink assemblies

By William Leventon, Contributing Editor



LPKF Laser & Electronics

The laser direct structuring process makes it possible to produce circuit layouts on 3D structures.

Ever heard of 3D molded interconnect devices? Many manufacturers haven't, even though 3D MIDs have been around for decades and offer some major advantages in a variety of applications that require both molded and electronic components.

Lately, however, 3D MIDs have been popping up in a growing number of products that need to pack a lot of functionality into a small space. Because many companies and industries are now turning out such products, it seems unlikely that 3D MIDs will be mired in obscurity much longer.

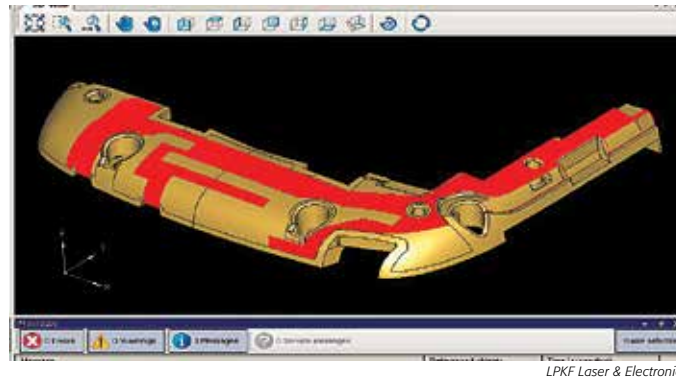
Smaller, lighter devices

For those who aren't familiar with them, 3D MIDs are injection-molded thermoplastic parts with integrated electronic circuit traces. Adding traces directly to an electronic housing or some other plastic part eliminates the need for separate circuit boards or lead-frame components, resulting in smaller, lighter devices with higher function density.

"We can use all the available real estate on a plastic part," said Stephan Schmidt, president of LPKF Laser & Electronics North America, Tualatin, Ore., whose German parent company is the developer of a leading 3D MID manufacturing process. Schmidt also pointed out that 3D MIDs can be molded into any 3D shape, allowing designers to use space more efficiently than those trying to bend circuit boards and other

2D components into 3D configurations.

In addition, the reduction in parts made possible by 3D MID technology boosts device reliability, noted Richard Macary, president of Arlington Plating Co., Palatine, Ill., which is involved in 3D MID manufacturing.



LPKF Laser & Electronics

The LDS process 'writes' circuits onto parts with a laser beam striking the molded part's plastic surface.

Growing market

Though reliable data on the revenues of 3D MID manufacturers is not available, a growing market for the devices can be inferred from the significant increase in 3D MID applications in recent years, according to Thomas Kuhn, managing director of technology and science for 3-D MID e.V., a Nuremberg, Germany, research association that supports the introduction of 3D MID technology. Success stories can now be found in all markets for conventional electronic modules, according to Kuhn.

The technology scored its biggest success when it was adopted to make antennas for mobile phones. These antennas are integrated directly into phone housings, saving space and eliminating assembly steps. Today, more than half of all smartphones are equipped with antennas produced by 3D MID technology, according to Kuhn. The technology is also used to make antennas for other mobile devices in the consumer electronics market.

Other key 3D MID markets and applications include:

- **Telecommunications:** antennas, terminals and coaxial plugs.
- **Automotive:** sensors, switches, connection elements, remote controls, 3D circuit boards and radar for adaptive cruise control.
- **Medical:** circuit boards, switch elements, tweezers, LED carriers and hearing aid parts.

Hearing aid components are probably the most common medical application, according to Schmidt. "There's a need there to go three-dimensional to exploit the little space that's available to the maximum extent," he said. When used to make microphone carriers, for example, the technology allows microphones to be mounted in a way that maximizes sound capture, he explained.

Manufacturing options

3D MIDs can be manufactured in a variety of ways. One technique involves the use of two-shot molding. First, two different resins are shot into an injection

mold, one of which is platable. Traces are then created in an electroless plating process that produces a metal layer on the platable areas.

According to Schmidt, this process has some significant downsides. For one, he said, a "fairly complicated" injection mold is required to put a circuit pattern on a part. In addition, the process limits circuit design to the mold design.

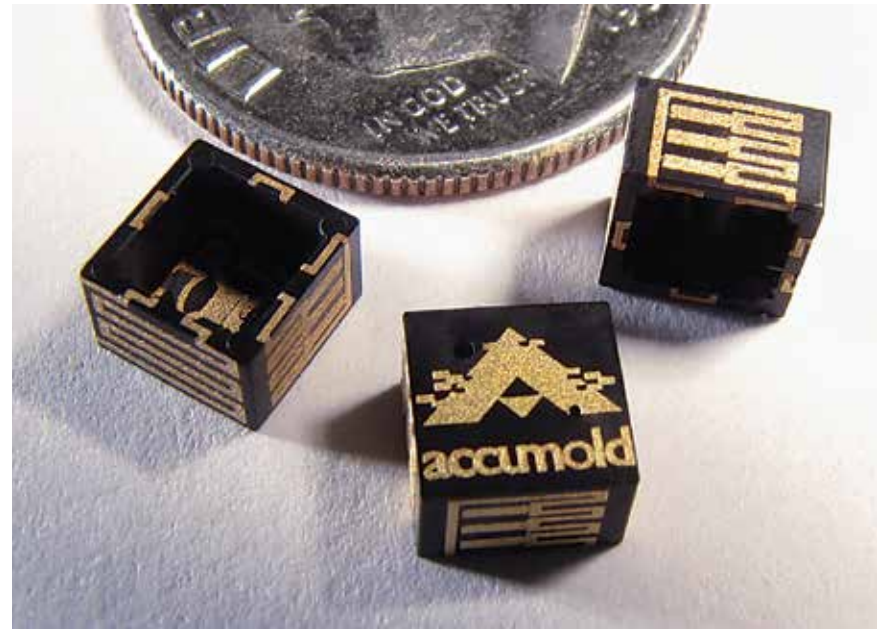
Another option for making 3D MIDs is laser direct structuring (LDS), a process patented by LPKF Laser & Electronics. In LDS, the base material is doped with an additive containing chemically inactive metal cores that can only be activated by laser radiation. After a component is injection-molded in a standard mold, a laser "writes" the circuit traces on the part. Where the laser beam strikes the material, it activates the metal cores, forming a precise track with a roughened surface. The metal particles along this track form the nuclei for the metal coating that follows.

As in the two-shot molding process, metallization takes place in an electroless bath. Anchored in place by the roughened surface, conductor path layers grow on the tracks where the molding material has been activated by the laser. Successive layers of copper, nickel and gold finish can be produced in this manner. Traces with widths as narrow as 0.005" can be produced with good definition, according to Macary of Arlington Plating, whose firm handles the lasing and plating aspects of the process.

Because the laser puts the circuit pattern on the part after molding, circuit design is separated from the design of the mold. Therefore, changes to the circuit don't require costly and time-consuming changes to the mold. All manufacturers have to do is transmit new control data to the laser.

LDS "allows part design creativity that extends beyond the limitations of an overmolded lead frame," said Aaron Johnson, marketing manager for Accumold, Ankeny, Iowa, which does both 3D MID and lead-frame molding. "You can trace on all sides of a part, because the plating will stick anywhere the laser strikes the plastic."

Still, Johnson sees 3D MIDs as complementing rather than supplanting overmolded lead frames. "There are distinct reasons why you would go one



Accumold

This sample part is approximately ¼" square and is molded with a platable PC/ABS-blended resin. The parts were laser-treated on all six sides and are plated with a final gold finish.

Contributors

Accumold
(515) 964-5741
www.accu-mold.com

Arlington Plating Co.
(847) 359-1490
www.arlingtonplating.com

LPKF Laser & Electronics North America
(800) 345-5753
www.lpkfusa.com

3-D MID e.V.
+49 911 5302-9100
www.3d-mid.de/2/

way or another," he said. "It really depends on where you need the traces to go and what you're ultimately trying to accomplish."

Assembly issues

One possible reason for not choosing 3D MID technology over other options is the process that follows plating: the placement of electronic components on the part surface. The pick-and-place machines used in most assembly processes are designed for flat circuit boards. Therefore, "mounting components in a three-dimensional space usually requires specialized equipment, or at least a different approach," Schmidt noted. As a result, he said, 3D MID assembly is typically more costly and time-consuming than conventional assembly.

'It's amazing to see designers getting fired up about the opportunity to start doing something in three-dimensional space.'

Nevertheless, Macary advises those considering 3D MID technology to analyze whether it actually will be more expensive in the end. This is because the technology also cuts costs by eliminating conventional components and assembly operations from the manufacturing process. "You can rethink the way you're making a part and actually make it less expensively," he said.

3-D MID e.V.

This sample is meant to showcase and demonstrate 3D MID technology.

In some cases, 3D MID assembly can be done using conductive adhesives or low-melting-point solders. To allow conventional soldering methods, however, higher-temperature materials are necessary. Here, 3D MIDs are at a disadvantage, Schmidt noted, because the temperature capabilities of injection-molded parts aren't quite as high as that of an FR4 circuit board.

On the bright side, Kuhn pointed out that new 3D MID materials include high-temperature thermoplastics, as well as thermally conductive plastics, thermosets and ceramics. Another new development is the appearance of colored LDS materials. In the past, LDS plastics were always black because that was the color of the additives. Now, however, pigments allow LDS materials to be adapted to a variety of color requirements.

In addition, it may soon be easier to prototype parts using LDS. Until now, Schmidt noted, the systems used to make 3D MIDs have been fairly complicated. To simplify things for designers, LPKF will be coming out with a line of small-scale laser plating systems. These systems will allow designers to "kick around ideas and try 3D applications in the lab," Schmidt said.

No clue

As for what else might be holding back 3D MIDs, the biggest factor might simply be a general lack of knowledge about the technology. "We have been promoting it for 4 years, and we still find so many people who don't have a clue about it," Macary reported.

After designers learn about the technology, the next hurdle is changing their mindset. "Probably the biggest challenge is getting engineers to think 3D," Schmidt said. "Most electronics designers are raised in the two-dimensional world of the circuit board, where components are always mounted flat."

But for those promoting 3D MIDs, Schmidt has good news: "I've been to many presentations of this technology, and it's amazing to see designers getting fired up about the opportunity to start doing something in three-dimensional space."

About the author:

William Leventon is a contributing editor for MICROmanufacturing. He has an M.S. in Engineering from the University of Pennsylvania and a B.S. in Engineering from Temple University. Telephone: (609) 926-6447. E-mail: wleventon@verizon.net