CONNECTORS & CORDS: Laser Lays it On

By Mary Lowe
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Simpler method improves potential for molded interconnect devices.

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Molded interconnect device produced with laser direct structuring technology.

Molded interconnect devices allow designers to create more three-dimensional connections with multiple points of contact, but the two-shot molding process used to produce the devices is complex, and once a MID device is molded, there is no way to add or subtract from its circuitry. A new technology, called laser direct structuring gives designers a simpler one-shot molding process that allows them to alter their circuitry after the molding process is complete, without a tooling change. LDS also provides the capability to produce a component with a higher resolution and smaller footprint.

Used since the late 80s, traditional two-shot molding technology requires two separate injection-molding steps, one with a non-plateable plastic for the body of the part, and another with a plateable plastic grade. An additional etching step provides for the proper surface condition of the plateable plastic for a subsequent metal plating process. Another commonly used technology to produce MIDs uses stamped metal pieces that are molded into a plastic component.


Step 1. Injection molding.

Three-step process

LDS, developed by LPKF, Garbsen, Germany, uses a simpler three-step process. First, the body of the part is created with standard injection molding, using a laser-activable plastic grade that contains a metal-organic complex. In the second step, the material is activated with a laser, which cracks open the organic complex in the doped plastic. The exposed metal atoms act as a seed layer for a subsequent electroless plating process, which grows 5 microns to 8 microns of copper on the laser-activated areas.

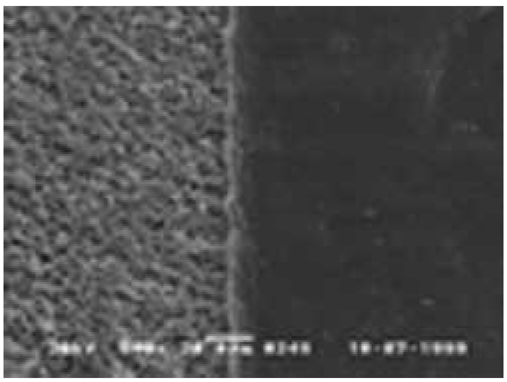
Step 2. Laser activation.

Electroless plating is a chemical reduction process that depends on the catalytic reduction of metal ions in an aqueous solution and a depositing of metal without the use of electrical energy. A positive side effect of the laser activation is that it creates a micro-etched surface, which provides for excellent bonding characteristics for the metal plating process without the need for an additional chemical treatment.

Step 3. Plating.

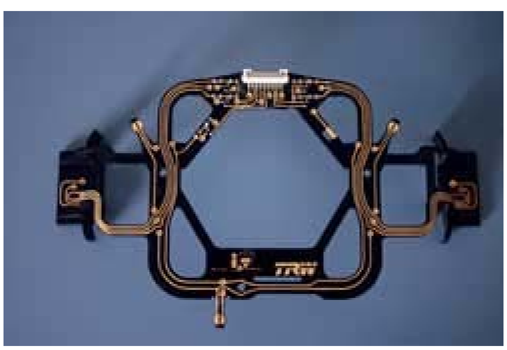
To achieve the correct laser activation, the additive must have several properties including: adequate solubility or distribution in the polymer matrix, good compatibility with the polymer matrix, high thermal resistance, resistance against bath chemistry, extraction-resistance, non toxicity, no diminution in electrical properties, and it cannot exhibit catalytic activity.

The laser activation is performed by a diode-pumped IR laser with a wavelength of 1,064 nm operating at a pulse repetition rate between 1 kHz and 100 kHz with a minimum beam diameter of 40 microns. With LDS, the fineness of the circuitry greatly improves. The laser can create traces as small as 100 microns with a 150-micron gap, compared to the 200-micron traces and 200-micron gaps produced with conventional MID technology. The increased resolution with LDS technology allows for better integration of the circuitry as well as improved performance, especially for high frequency applications such as an antenna.



Laser activated surface. The laser creates a micro-etched surface that provides superior peel strength for the plated metal.

Lastly, copper is used to create tracks and paths for the circuit structure during the electroless plating process. In many cases nickel and gold, which does not oxidize, are also added for a better surface finish.



MID component produced with LDS technology.

Alterations Made Easy

With LDS, designers need not worry about the type of circuitry that will be on the part. Carriers can be produced in mass quantity and the circuitry is later added via CAD data, which can be modified on demand. Consequently, the process naturally lends itself to prototyping. In a cell phone application, for example, where modifications often must be made with frequency regulations or to improve the performance of an antenna, the part can be molded in quantity ahead of time, and the circuitry is then added with the laser system at any given time. LPKF's LDS technology is compatible with surface mount technology, so electronic components can be soldered to circuitry.

"The flexibility with this process is very, very high - you can change your data at any given time, and then have different circuitry, so you don't have to go back and produce another mold," says Stephan Schmidt, president of LPKF North American Operations, based in Wilsonville, Ore. "The turnaround time for a design change with this process is instant because you don't have to change anything but your data."

MID produced hearing aid component. Device is shown after injection molding (left), after laser activation (middle), and after metal plating (right).

By contrast, the standard two-component, injection-molding and hot-stamping MID processes are tied to product-specific tools to create a circuit. Prototyping shortly before production is nearly impossible. Design modifications are often cost-prohibitive, and the increasing miniaturization of the circuits leads to a rise in tooling up time and expense.

LDS grade materials are available from various manufacturers. BASF produces an LDS grade of its glass fiber-reinforced PA6/6T. This material has good mechanical properties and a high melting point (295 DegC), which makes the material a good candidate for MID with soldered components. Lanxess (formerly part of Bayer MaterialScience) offers LDS compatible versions of both its low-warpage PBT and PBT/PET blend. Liquid Crystal Polymer in LDS grade is available from Ticona. This material has an extremely high melting point (335 DegC), excellent electrical characteristics, high stiffness in thin wall sections and a low coefficient of thermal expansion.

The miniaturization of a hearing aid from Acuris P Company of Siemens Audiologische Technik GmbH was achieved using LDS from LPKF.

Multiple Uses

Because the structural part of the device actually becomes circuitry with LDS technology, designers save space and weight. This makes the technology appropriate to a number of applications where a smaller device is required. The miniaturization of a hearing aid from Acuris P Company of Siemens Audiologische Technik GmbH, for example, was achieved using LDS from LPKF.

Other areas where LDS technology plays a major role in the production of MIDs are the wireless and security industries. Driven by continuous miniaturization, increased functionality and ever short product lie, LDS technology is able to provide the necessary flexibility and resolution for such applications.

Although LDS presents several benefits over traditional MID processes, it supplements the technologies rather than replaces them. Two-shot molding still is more appropriate for most complex MID and circuit geometries, because the laser cannot reach all areas on complex parts or the backside of a double part without additional steps. At very high production volumes, for example, those exceeding 500,000 parts per year, the cost of the additional manpower can offset the expense of using a two-shot tool.

LPKF MicroLine 160: Laser system for the production of MIDs in LDS technology.

Fully exploring the advantages of MIDs takes a fresh approach and some out-of-the-box thinking. That means electrical engineers and mechanical designers will be required to approach LDS MID product designs jointly.

The simplicity of LDS and the reduction in prototype costs with the technology should make it the industry choice for MID design, Schmidt says.

"I believe that the full potential of MID has not been recognized because it was too expensive and too difficult to produce prototypes," Schmidt says. " The ongoing proliferation of LDS technology is about to change this, making MID more accessible for most designers."

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