CircuitsUnusual

By Ken**Gilleo**

Ready for MID?

Some may recall the *3D Circuits* initiative of the 1980s. Proponents hoped that molded circuits would garner a nice chunk of the printed circuit market. Plastic molding, combined with any number of conductor-generating processes, was used to produce both 2D and 3D shaped circuits. These products could serve as a platform for components and provide electrical interconnects, abut they could also incorporate integrated mechanical features like ribs, stand-offs, bosses, brackets, slots, and holes. The basic concept was a good idea twenty years ago and it seems to makes even more sense today. But molded circuits failed to capture all but a tiny market niche, and for many valid reasons. Today, the molded circuit idea is here as Molded Interconnect Devices (MID). But is the timing and technology right for a comeback? I think so, and here's the reasoning. why

The idea of shaping printed circuits out of plane can be traced back to the late 1950s and 1960s when companies like IBM, Motorola and ITT disclosed as thermoformed circuits. But these early designs were not much different than flexible circuitry on a thermoformed backer that we see today. The events of 1980s produced some authentic 3D circuits with conductors on top, bottom and sides that could be interconnected. However, several factors hindered success. The big resin makers took over (acquired companies) and pushed their own agenda—creating an outlet for high-priced resins. There wasn't much outsourcing back then so the logistics of merging plastic shaping and circuitry processes was not favorable. SMT, the ideal assembly process for 3D circuits, was still struggling to become more prevalent. The molding process also required long-running designs to amortize the high tooling cost and not many were found.

The basic MID idea is simple and appealing. Injection mold high-temperature plastic and then form, or apply, circuitry. There are many older and several newer methods available, with some proven in manufacturing. Traditional circuitry processes, modified for 3D, can be used. Flexible circuits can be in-molded but this concept limits design freedom. Plastic parts can be over-plated with copper and then patterned by photo etching. Two-shot molding can also be used as the patterning method but with lower resolution. The conductor pattern is molded with resin catalyzed for plating and the other shot is ordinary resin. Plastic molders can use two-shot presses commonly employed in making two-color products like taillight lenses with red and clear plastic. But standard presses also work; the part from shot 1 is placed in another mold and shot with the second resin. Newer methods, like laser-patterned plating, are also available. LPKF Laser & Electronics AG (Germany) offers a process and equipment (MicroLine 3D IR Industrial) where the laser beam "writes" a platable pattern on the molded part. The laser activates the surface and makes it selectively platable by causing organic metallic compounds in the resin to decompose to metal that can be plated.

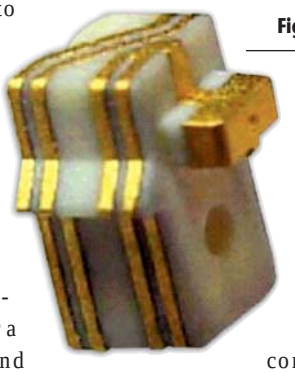

Figure 1. Mobile Phone Antenna (Ref. 1).

MID can allow the plastic molder to use standard equipment and processes and circuit-generation can be handled by some contract platers and by some circuit shops. Some of the processes, like two-shot molding, don't even require new equipment. MID products could therefore be made within existing infrastructures— the plastic molding, plating, and printed circuit industries.

But does anyone care? What important problem does MID solve in a practical way? First of all, there is not much point in attacking markets that are well served by existing circuitry and this was another mistake during the 1980s. Both traditional flat rigid circuits and multiplanar flex are well established, efficiently produced and satisfy the needs of their customers. MID needs to target applications where true 3D circuits and interconnects or other features, solve problems and offer better value.

Portable communications, automotive, and medical are possible areas for MID. But automotive has used molded plastic with conductors for a long time. Quite a few automotive applications can be satisfied by insert-molding prefabricated metal conductor arrays (analogous to metal lead frame molding for electronic packages). MID may not compete well here and more complex designs may be a better fit. Nokia helped develop a 3D antenna shown in Figure 1 that seems like a reasonable type application.

My pick for MID is electronic packaging, especially cavity designs, now made with ceramic and metal. Thermoplastics have not been widely used for IC packaging, but this may be changing. Thermoplastics, like LCP, can outperform epoxies and don't need halogens to pass flammability standards. And it looks like thermoplastic cavity packaging for MEMS and some optical areas is moving to commercialization in 2004. Acceptance of thermoplastic packaging made by insert-

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molding lead frames should help MID circuits and packages made with MID processes. Since MDI needs high-volume designs to amortize tool costs, targeting standardized packages looks like an attractive target. But can MDI deliver the density, performance and be cost-competitive with other packaging technologies? Those will be the issues and Time will tell. **CT**

Reference

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