Microvia Technology Trends: Product Boards and IC Packages

E. Jan VARDAMAN*

1. Introduction

Microvia structures comprise interconnections formed using blind vias measuring less than 150μm in diameter on a 350μm or smaller diameter pad. There are many different fabrication methods and a number of different names describing the technology and processes. In Japan, the preferred name for the technology is build-up board. In North America some companies call it sequential build-up (SBU), while others use the term high density interconnect (HDI). Whatever the name, the technology results in a higher density substrate or board with finer lines and spaces and smaller vias and capture pads than with conventional technology. Because the various approaches for achieving these higher density substrates all reflect the common attribute of small vias formed in the dielectric layers by laser ablation, photovia techniques, or plasma etching, we prefer the term microvia.

Microvia technology boards have emerged as one of the most important technological developments of the last 35 years for the printed circuit board industry and may well be as revolutionary as the advent of glass epoxy multilayer technology which was introduced into the PCB industry in 1965. There are a few novel via fabrication methods for microvia structures, but laser and photovia technology are the most common. IBM’s Surface Laminar Circuit™ (SLC) photovia process was one of the earliest microvia technologies, but laser via fabrication is now the most widely adopted technology. Seventy percent of the world’s microvia board production capacity uses laser ablated vias.

2. Two Markets for Microvia Technology: Product Boards and IC Packages

There are two distinct markets for microvia technology—each with different requirements. One market is for product boards, the other is for IC package substrates. These markets have different drivers, reliability requirements, and price structures.

Microvia board technology was first introduced in a wide range of Japanese products such as mobile phones, camcorders, car navigation systems, PC cards, and notebook computers. Mobile phone makers in North America and Europe have also started to use microvia boards in their products and this use is expected to increase dramatically. Workstation and network system makers are expected to use the technology in future systems.

The use of microvia technology in mobile phones is the largest market today, and microvia boards are expected to be used even more in digital cellular phones as denser packaging of fine-pitch parts becomes more critical. Miniaturization in mobile phones has been enabled by the combination of chip-scale packages (CSPs) and microvia board technology. The CSPs provide the smallest size package reducing mounting area, while the microvia boards are required to route the signals from underneath the fine-pitch CSPs.

Digital camcorders and cameras also depend on microvia
board technology to meet form factor requirements dictated by the marketplace. These products also use CSPs and microvia boards for the same reasons they are used in mobile phones. Sony’s digital camcorder was one of the first products with microvia boards and fine pitch CSPs. In the first version 20 of the 40 ICs were packaged in CSPs. These CSPs were mounted on microvia boards fabricated using a photovia process. The introduction of this product was followed by many others, including Matsushita, JVC, and Sharp. Today, it would be difficult to find a digital camcorder without a microvia boards and both laser and photovia boards are used.

Notebook computer makers such as Fujitsu, IBM, Matsushita, NEC, and Toshiba have found the need for microvia boards in their notebook and palmtop products. Some products use modules or daughter cards that are fabricated with the microvia process, others feature microvia motherboards. Additional products such as personal communicators or personal digital assistants (PDAs) are also seeing the introduction of microvia board technology.

Many of the first product boards featured photovia process, but laser fabricated vias are increasingly common. In addition, novel fabrication methods such as Toshiba’s Buried Bump Technology are also found in production. Microvia product board feature sizes vary, but small vias and capture pads are common (see Table 1).

The driver for microvia technology in IC packages is high I/O counts coupled with decreasing flip chip bump pitch—approaching 160 μm for ASICs and 200 μm for microprocessors over the next few years. Semiconductor makers such as Fujitsu, Intel, LSI Logic, Lucent, Mitsubishi, Motorola, NEC, Toshiba, Texas Instruments, and VLSI are among the many companies adopting this technology. Products containing high pin count FC-BGAs using microvia substrates include workstations and servers. Silicon Graphics ships systems containing an ASIC packaged in a 1,521-ball PBGA. The substrate is W.L. Gore’s PTFE material featuring laser via fabrication. Vias in the substrate are 50 μm with 87μm capture pads.

Microvia technology used in these substrates must have via diameters and capture pads that are much smaller than microvia product boards. Table 2 provides examples of current microvia substrates used in production.

### 3. Growing Markets for Microvia Technology

Since the first microvia shipments began in the 1990s from IBM’s Yasu Japan facility for the IBM ThinkPad, the market for microvia boards has grown dramatically. In 1996 it was estimated to be a $200 million market—a small fraction of the total PCB market. Today the market is over $1.6 billion and is expected to grow to more than $8.6 billion in 2005.

Worldwide microvia board production capacity is estimated to be 200,000 square meters per month (see Fig.1). Not surprisingly, Japan represents 61 percent of the total with almost 124,000 square meters of monthly production. Applications in Japan include product boards and IC packages. Europe follows next with more than 27,000

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<th>Table 1. Microvia Product Board Examples</th>
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<tr>
<td>Product</td>
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<td>------------------------</td>
</tr>
<tr>
<td>Mobile Phones</td>
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<tr>
<td>Digital Camcorders</td>
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<td>Notebook PCs</td>
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<td>Handheld PCs</td>
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<th>Table 2. Microvia Features for IC Package Substrates</th>
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<tr>
<td>Product</td>
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</tr>
<tr>
<td>Microprocessor</td>
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<td>ASIC</td>
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Microprocessors represent the high-volume driver for microvia boards in IC packages. With Intel’s announcements of the use of flip-chip with a microvia organic laminate substrate for its mobile Pentium II and all Pentium III processors, the volumes are projected to increase significantly. In the first year of introduction for mobile products, Intel shipped 15 million parts. Intel’s substrate is 31 mm × 31 mm with two build-up layers on each side of the two-layer core. A photovia process is used for the organic substrate. Intel’s use of microvia substrates for IC packages is expected to increase with projections for flip-chip interconnect for all CPUs as of 2000. AMD and Motorola are expected to supply microprocessors in laminate packages using microvia substrates starting within the next three years.

ASIC makers have already started to use microvia boards. Some of these packages can be found in workstation/servers. Silicon Graphics ships systems containing an ASIC packaged in a 1,521-ball PBGA. The substrate is W.L. Gore’s PTFE material featuring laser via fabrication. Vias in the substrate are 50 μm with 87μm capture pads.

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Fig. 1 1999 worldwide microvia production capacity by geographic region (square meters per month).

North American companies.

4. Future Trends

Microvia technology is real and flourishing. Early applications continue to use the technology, while new applications are emerging. Many of new IC designs, especially microprocessors and ASICs, will be packaged as flip chip on microvia substrates. Portable products will continue to use microvia board technology, as will digital camcorders and cameras, Japanese notebook computers, and other portable communications products. Workstation and network system manufacturers are beginning to design products with high density interconnects fabricated with microvia technology. Microvia technology will become increasingly widespread as production capacity increases and prices decline.

References

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