

Microvia Drilling Technology

Kunio Arai, Akira Irie, Osamu Kuze, Kaoru Matsumura, Kiyoshi Yamaki
Hitachi Via Mechanics, Ltd
Kanagawa, Japan

Osamu Sekine, Jenny Tran
Hitachi Digital Graphics (USA), Inc
San Jose, CA

Introduction

The need for the high density provided by Build-up PWB installed in the mobile communication products requires the general trend towards a gradually smaller hole diameter.

For the micro via drilling, it has been categorized by the process as shown in Figure 1 so far, and due to the technology development, further smaller holes are processed. This paper presents these up-dated technologies.

CO₂ Laser

Resin Direct Micro via Drilling by CO₂ Laser

Recent packaging board requires such micro vias with the diameter of Blind Hole: 60- 70 μm (2.4- 2.8 mil) and total drilled numbers of vias: 400- 500 k/ board.

For this requirement, two beam CO₂ Laser machines are utilized in the mass production. The machine is also equipped with 1,000 Hz Galvano scanner and the improvement of drilling condition; the drilling speed has almost doubled at 800-900 holes/ sec, compared with conventional method.

For the next generation of the packaging board, less than 50 μm micro via drilling is expected and it has been studied at R&D level for mass production application. (See Figure 2)

Glass-reinforced Material

Due to the cost and mechanical strength advantages, the utilization of glass-reinforced material (FR-4) becomes advantageous.

In order to keep the high beam energy at the circumference of the beam, the Laser beam mode is transferred into a "Top-hat" shape by optical method and it features and enables the conformable evaporation of both resin and glass at the inner wall of the hole, even whose evaporation temperatures are different. (See Figure 3)

Mass production example with diameter of 100- 125 μm (4- 5 mil) at the speed of 400- 500 holes/sec is obtainable.

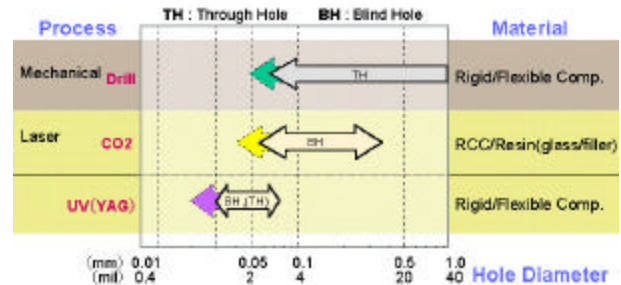


Figure 1 - Recent Technology Improvement for MicroVia

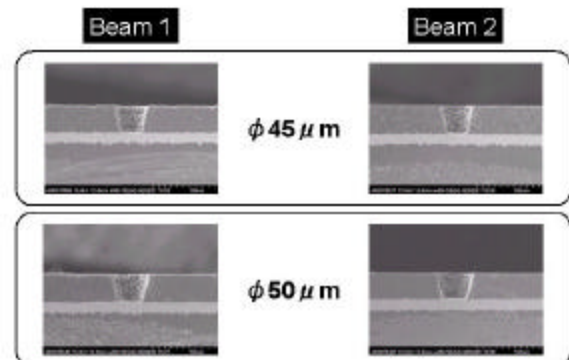


Figure 2 - Typical Hole Quality for Multi CO₂ Laser

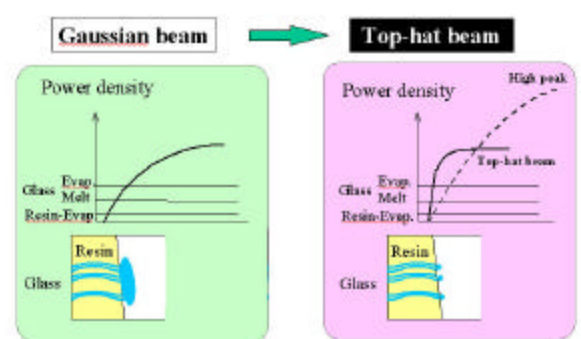


Figure3 - Improvement for Material with Glass

Cu (Copper foil) Direct Drilling

In the conformal mask method by using CO₂ Laser, for the purpose of opening the window the coated copper foil is etched first, then the Laser drilling process follows. (See Figure 4.)

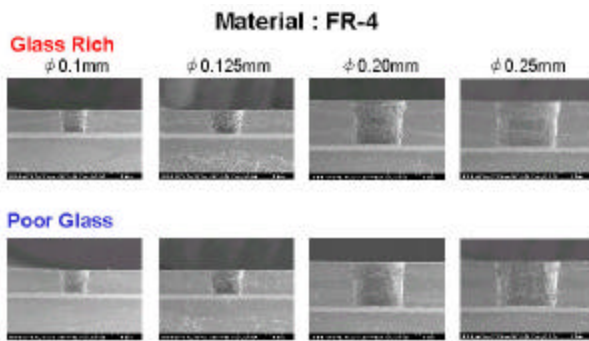


Figure 4 - Hole Geometry of CO₂ Laser

After four years of study, the actual production is now practiced with Cu Direct drilling, since the consistency of hole diameter, shape and quality becomes obtainable with various improvements such as the beam mode improvement of the Laser machine, the thin copper foil improvement by foil makers and effective surface treatment applied. (See Figure 5.)

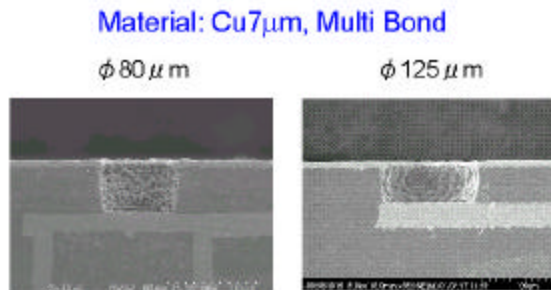


Figure 5 - Typical Hole Example for Cu Direct Drilling

This Cu Direct method makes it possible to drill even through holes of 100 μ m (4 mil) diameter at R&D level. (See Figure 6.)

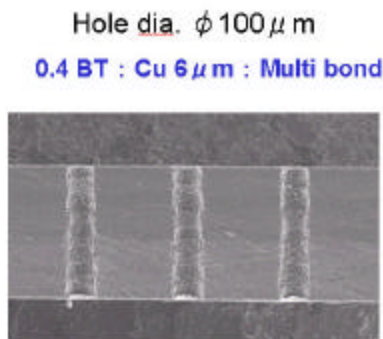


Figure 6 - Through Hole Example

UV Laser Drilling

As mentioned previously, the further smaller micro via drilling is expected in near future for the next generation board, such a hole diameter as 30- 40 μ m (1.2- 1.6 mil).

As this drilling range is below that of CO₂ micro via drilling capability, the UV Laser application is anticipated.

At R&D level, the drilling of 20 μ m (0.8 mil) is practiced. (See Figures 7 and 8.)

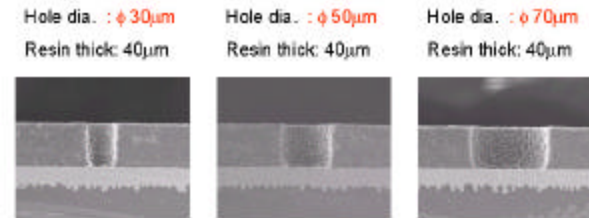


Figure 7 - UV Laser Drilling Example

High Aspect Ratio Hole by UV

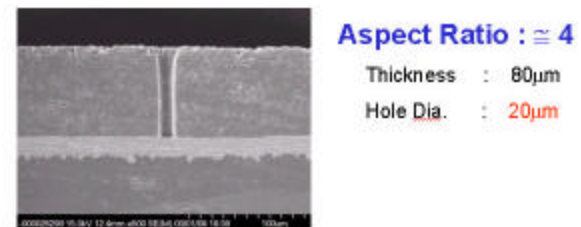


Figure 8 - UV Laser Drilling Example

Combination Drilling of UV and CO₂ Laser

For the blind via drilling with connection between first and third layers for the main board of base station, the combination drilling of UV and CO₂ is utilized.

Surface copper foil is drilled by UV Laser, and then CO₂ Laser is applied for the similar manner as the conformal process.

The benefit of this method is the improved efficiency of CO₂ Laser process when much of resin removal is required. (See Figures 9 and 10.)

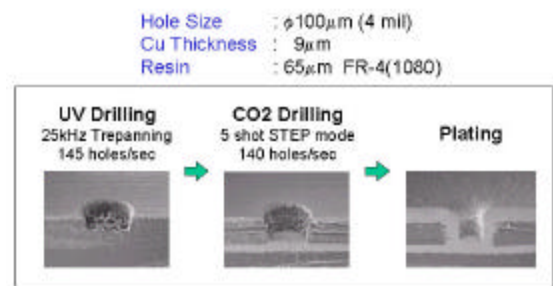


Figure 9 - Test Result, UV+CO₂ Laser Drilling

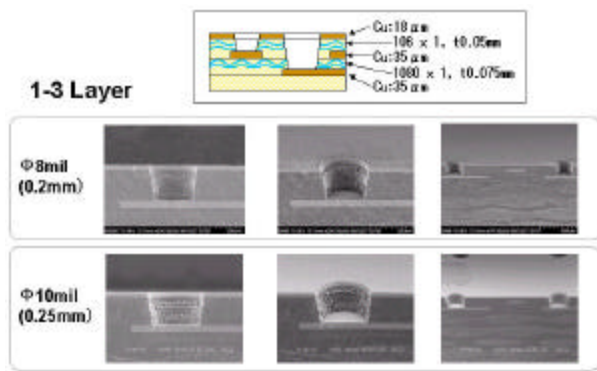


Figure 10 - UV+ CO₂ Laser Drilling

Mechanical Drilling

The through hole drilling is widely made by the mechanical drilling machine, although the use of Laser drilling is studied in R&D level.

This through hole drilling requires smaller diameter than 0.1 mm (4 mil) for the next generation board, and the development is under way.

The maximum drill speed is 250 kmin⁻¹ and the hole diameter of 50- 100 μm (2- 4 mil) is obtainable. (See Figures 11 and 12.)

The hit rate of 500- 600 (hit/min) makes it possible for the productivity of 9,000- 10,000 (hole/ min/ machine) when the 6 spindle drilling machine is used with three high and a hole diameter of 100 μm.

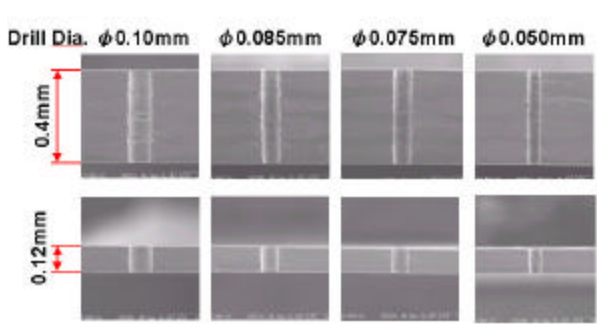


Figure 11 - Micro Hole Drilling by 250kmin⁻¹ Spindle

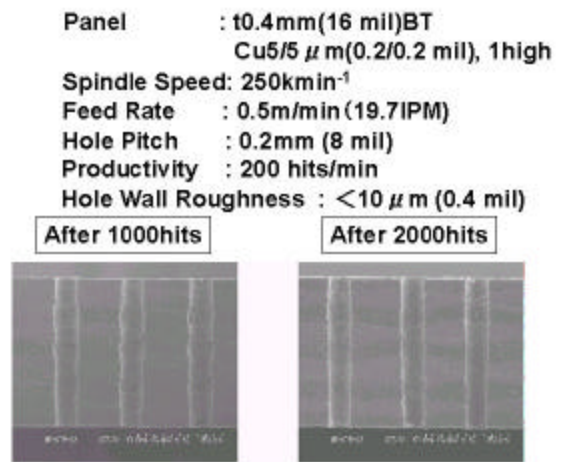


Figure 12 - Cross Section f0.050mm (f2mil)

References

1. K. Matsumura, etc: Cu Direct Drilling Technology by CO₂ Laser Proceedings of the 13th JIPC Annual Meeting, March, 1999, Tokyo.
2. K. Arai: Trends of Laser Drilling Technology, Proceedings of the 14th JIPC Annual Meeting, March, 2000, Yokohama.