Laser Drilling System ML605GTW II-5150U

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1. Introduction

Since the mid 1990s, build-up technology has accelerated the spread of high-density, high-definition, thin-substrate printed circuit boards (PCB), thus contributing to the development of cellular phones and other electronic devices. Laser drilling used with the build-up technology is considered the standard method and a vital process for making through holes in each layer of a PCB. In response to various PCB requirements, the PCB laser drilling system has been continuously improved in the last 10 years. For better mechanical and electrical characteristics, PCBs are becoming more sophisticated in structure and material, but this makes it harder to raise productivity and quality in the drilling process. To solve these issues, we have developed the ML605GTW II-5150U laser drilling system (called "GTW II"). This article introduces the features of GTW II.

2. Features and New Technologies of GTW II

The GTW II inherits the twin-head, twin-work schemes of our conventional ML605GTW-5150U machine (called "GTW"), whereby two boards on the left and right tables are simultaneously processed using simultaneous two-beam spectroscopy. In addition, new technology is introduced for higher productivity. Figure 1 shows the appearance and the following sections describe the key features of GTW II.

2.1 High productivity

Mitsubishi Electric's PCB laser drilling system employs a digitally controlled galvano system for high-speed, high-precision laser drilling. The digitally controlled galvano system consists of three key components: a special control unit for high-speed galvano control, an amplifier, and a galvano scanner driven at high speed. By improving all key components of the

Fig. 1 ML605GTW-II – 5150U

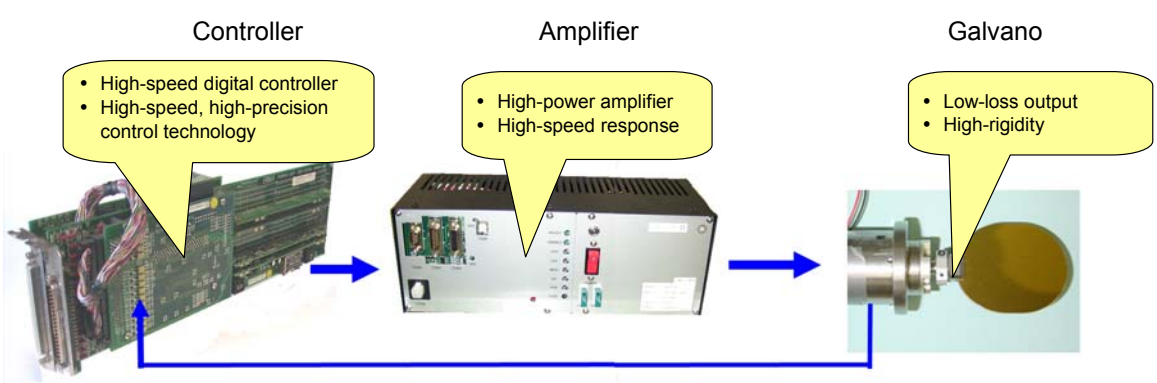

Fig. 2 Components of digitally controlled galvano system

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galvano system as shown in Fig. 2, the GTW II offers high precision and dramatically faster galvano processing. In addition, the conventional 5150U CO_2 laser oscillator, which was developed in-house, has been improved to operate stably at a high pulse repetition rate up to 10 kHz, thus reducing the laser irradiation time for burst processing that irradiates multiple laser pulses consecutively onto the same hole.

As a result of improving the digitally controlled galvano system in terms of galvano speed and reducing the laser irradiation time by increasing the laser oscillator frequency to 10 kHz, the GTW II has achieved industry-leading productivity of about 3000 holes/sec, which is about 30% faster than our conventional model GTW (Fig. 3).

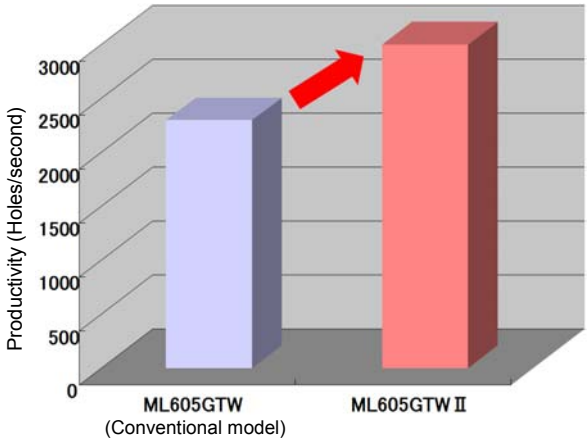
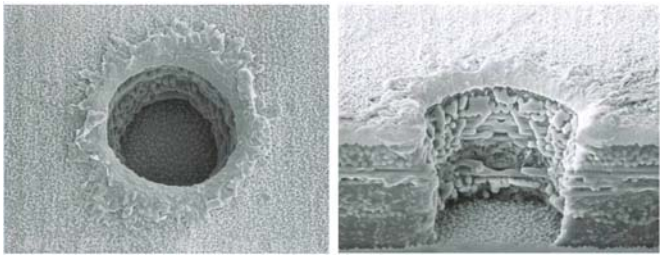


Fig. 3 Improvement in the productivity (in comparison with previous machine)

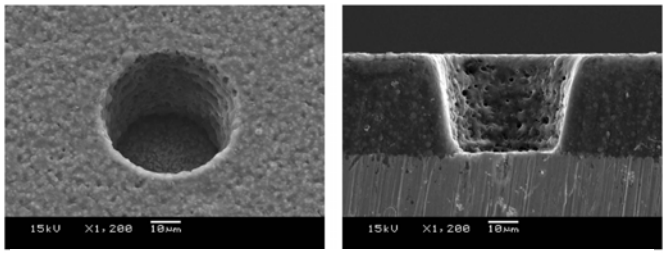
2.2 High-quality processing

To increase the performance and lower the cost of PCBs, there is growing demand for direct processing of copper. The newly developed GTW II offers stable copper direct processing. Figure 4 shows an example of copper direct processing with the GTW II, in which irradiation of a laser beam having a high peak power is considered ideal for stable penetration of the surface copper foil. Mitsubishi Electric's unique laser oscillation technology enables its 5150U CO_2 laser oscillator to generate two kinds of pulses: a high-peak short pulse and a low-peak long pulse, allowing copper direct processing to be performed with ideal high-peak short pulses. In addition, the combination of these two kinds of pulses provides high-quality copper direct processing as shown in Fig. 4, where high-peak short pulses ensure stable penetration of the surface copper foil and then the laser pulse is instantaneously switched to the low-peak long pulse mode. Furthermore, for environmental reasons, PCB substrates are increasingly made of resin materials that are halogen free, and new materials are emerging with many fillers added to improve the mechanical characteristics. These trends of new resin design make laser processing more difficult. In particular, a package PCB that needs fine drilling imposes very severe requirements on the laser processing. In response, the GTW II uses the high-performance fθ lens which was developed in-house and gives superior focusing performance. As a result, stable and high-quality laser processing has been achieved even for fine holes with a 50-μm diameter on the new materials of package PCB applications that used to be problematic for laser processing (Fig. 5).



Glass-epoxy resin bonded with copper foil
Hole diameter 120 μm

Fig. 4 Copper direct drilling



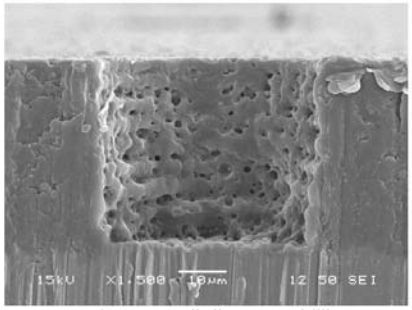
Epoxy type resin with filler Hole diameter 50 μm

Fig. 5 Micro drilling of new package material

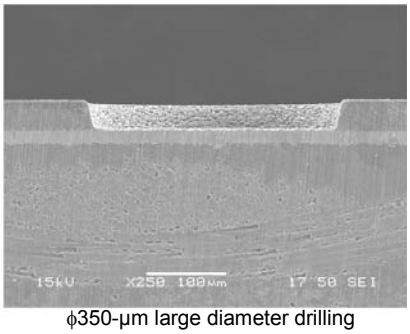
The GTW II also inherits the laser processing capability that satisfies various requirements from small to large diameters. Some of those applications are shown in Fig. 6.

3. Conclusion

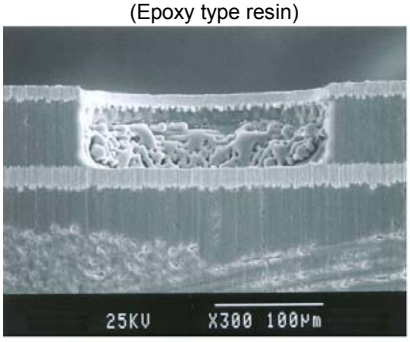
The newly developed ML605GTW II-5150U PCB laser drilling system offers high productivity and high-quality processing. The new method of PCB manufacturing is leading to innovative PCB design rule and mounting technology, and the emergence of more sophisticated and convenient electronic devices. Laser drilling applied to the PCB manufacturing process has had similar impact, and over 10 years have already passed since it was first used for mass production. PCB design will likely shift rapidly toward higher-density, higher-definition and thinner substrates; applications of laser processing will expand; and various new requirements will emerge. To meet such needs and contribute to the progress of mounting technology, we will continue to develop new laser processing systems.



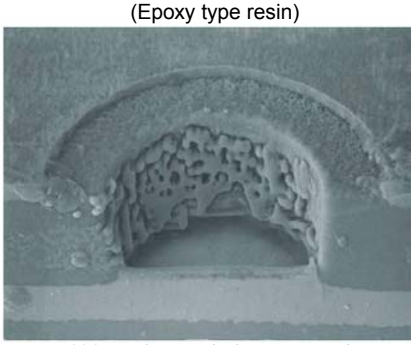
ϕ50-μm small diameter drilling
(Epoxy type resin)



ϕ350-μm large diameter drilling
(Epoxy type resin)



ϕ200-μm conformal processing
(Glass-epoxy resin)



ϕ100-μm large window processing
(Glass-epoxy resin)

Fig. 6 Application example